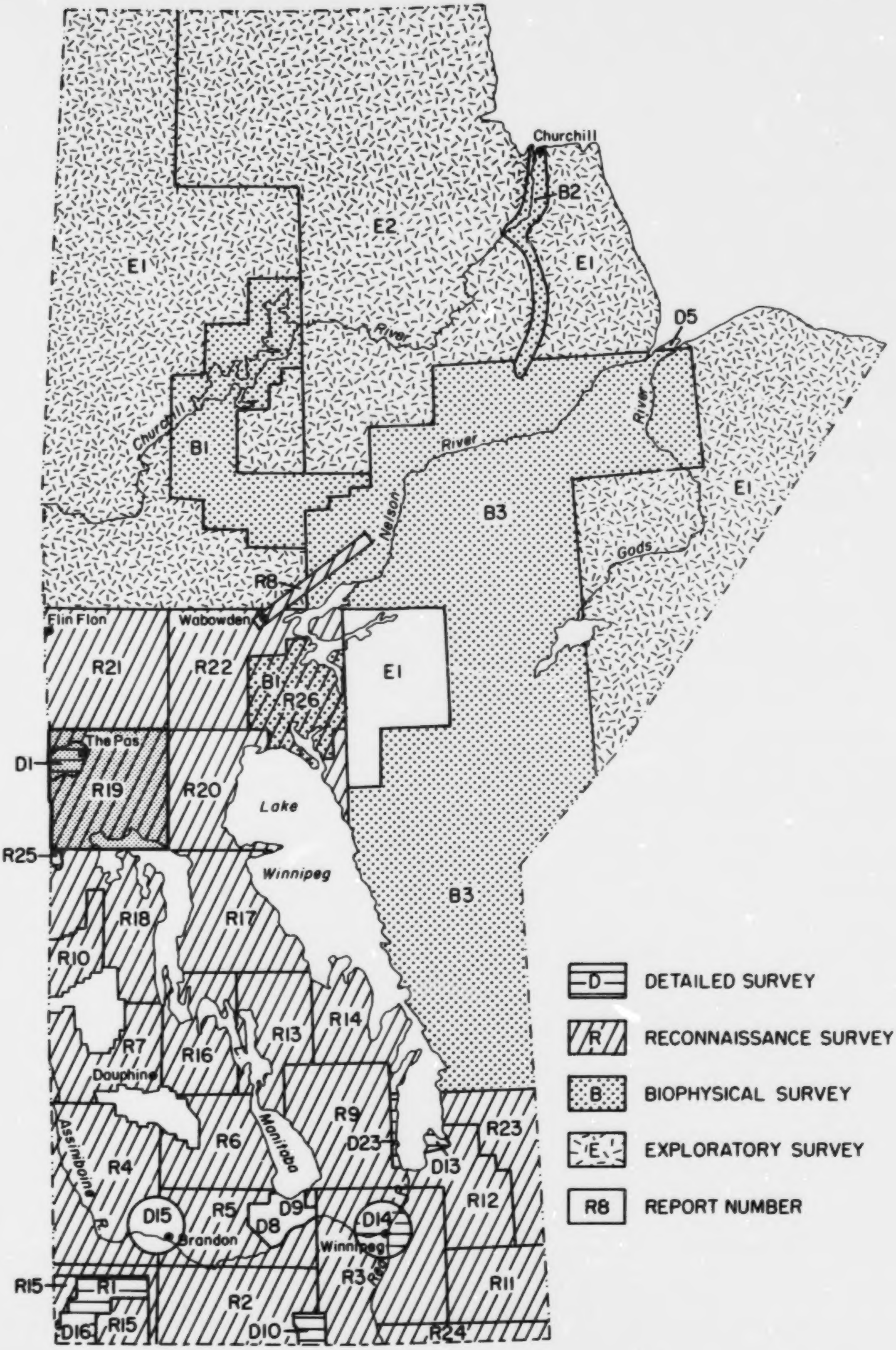
SOILS OF THE PAS AREA

CANADA·MANITOBA SOIL SURVEY

SOILS REPORT No. 22

1982

Cover: Winter landsat image of The Pas moraine, approximate scale of 2.5 cm = 10 km.



SOILS REPORT No. 22 1982

SOILS OF THE PAS AREA

by

L.A. Hopkins and R.E. Smith

CANADA-MANITOBA SOIL SURVEY

AGRICULTURE CANADA

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PREFACE

The report of the Soils of The Pas Area is one in the continuing series of reports devoted to the description of soils in Manitoba. Field studies of the characteristics and quality of the soils in The Pas area (Manitoba portion of N.T.S. Map Sheet 63F) and field mapping of their distribution were initiated in 1969 and continued through 1971. Sampling and final correlation continued through part of 1975 and 1976. The purpose of the report and map is to supply basic information about the soils of the area, their distribution, their capability for agriculture and forestry and their properties affecting engineering uses, and recreational developments.

This publication consists of two parts, a coloured soil map and the report. The soils were mapped and classified according to the system of soil Classification for Canada (1974). Representative soils were sampled and analyzed so that the soils could be evaluated for various uses.

The survey of The Pas Map area was carried out at a reconnaissance or medium intensity scale of 1:126 720 or 1 inch to two miles. The soil map indicates the distribution and area of soil map units which are described in terms of soil series or phases of soil series wherever possible at this scale of mapping. Single map units described by the soils of a single series occur mainly within alluvial areas where the soils are often uniform over large continuous areas. In till landscapes, characterized by complex topography, the various kinds of soil occur in intricate patterns which can not be shown separately because of the scale of mapping. Here, compound map units consisting of soils of two or more series are identified by a series symbol for each component, followed by a number representing the decile portion of that soil in the map unit. Mapping units are coloured on the map according to the dominant soil identified in each simple or compound map unit. A key to colour and symbol designation for each soil appears in a descriptive legend along the side of the map. A brief summary of the soil properties, related landscape features and a generalized vegetation description typical of each soil in the map area is included in the map legend.

The report is presented in 4 parts. Part 1 provides a general description of the area. Part 2 describes the physical features such as bedrock geology and surface deposits, relief and drainage, climate and vegetation that affect the development of the soils. Part 3 deals with factors affecting soil development, soil classification, the procedures used to map the soils and a detailed description of the physical, chemical and morphological features of the important soils in the map area. Part 4 presents an evaluation of the soils in the area for dryland and irrigation agriculture, forestry and interpretation for various engineering properties related to urban development planning and recreational developments.

Individual maps showing the relative suitability or limitation of soils for agriculture, forestry and engineering and recreation uses can be developed by using the soil map and relative interpretive information contained in the various sections of the report.

Four appendices are included in the report. The first contains a glossary of common terminology used in the report, the second is a listing of terminology used to describe soils, the third contains definitions of geological term used to described landforms and surface deposits and the fourth contains a series of guide tables that are used to rate soils for selected engineering and recreation uses.

During the course of the survey, a considerable amount of data for the soils mapped in The Pas area was generated, that, for practical reasons cannot be included in this report. These data are currently being input into the Canada Soil Information System (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of data for soil characterization and interpretations. In addition, the Cartographic File of CanSIS provides a capability to produce derived maps of various kinds quickly and inexpensively. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps showing drainage, texture of surface deposits, slope, stoniness and salinity. A package of interpretive maps and single feature derivative maps can be made available on request to the Canada-Manitoba Soil Survey, Room 362, Ellis Building, University of Manitoba, R3T 2N2.

ACKNOWLEGMENTS

Grateful acknowledgement is made to the following persons and agencies.

J. Day, Land Resource Research Institute, Ottawa for review of soil map and correlation of descriptive legend.

The staff of the Cartography Section, Land Resource Research Institute for publishing the soil map and inputting the map into the CanSIS cartographic file.

R. DePape and J. Griffiths for compiling the original map manuscript and drafting of related diagrams and sketches for the report.

J.G. Mills of the Soil Science Dept. for assistance during computer input of manuscript.

D. Sandberg for inputting the text and assisting in compilation of the report.

The staff of the Analytical Laboratory, Canada-Manitoba Soil Survey, for chemical and physical analysis characterizing the soils in the map area.

The soils were mapped by G.J. Beke, M. Capel, L.A. Hopkins, G.F. Mills, and C. Tarnocai.

Those assisting in the field work were W. Fraser, L. Malazdrewicz and F. Wilson.

SUMMARY

The report on the soils of The Pas Area covers an area of approximately 12 784 square kilometres or 1 278 476 hectares of which 4 304 square kilometres or 430 480 hectares are water (Manitoba portion of National Topographic Series Map Sheet 63F). The mapped area occurs within three physiographic divisions of the Interior Plains of Canada: The Westlake Plain, The Cedar Lake Plain and The Cumberland Lake Lowland.

Climate within the map area varies with physiography and elevation but in general is subhumid, continental with 491 mm of annual precipitation and a mean annual temperature of about -0.3 degrees C. There is a definite summer maximum of precipitation. The cool subhumid to humid climate of the area results in forest growth typical of the Manitoba Lowlands sections of the Boreal Forest Region. Coniferous species dominate the tree canopy but deciduous trees and herbaceous species are abundant in some areas (Red Deer Lake, and Saskatchewan River Delta).

The Pas map area is characterized by low relief with the exception of some areas on the south side of The Pas Moraine which are steeply sloping. Surface drainage is poorly developed over most of the map area.

Water accounts for 34 percent of the total map sheet and the formerly mapped Pasquia project accounts for 4 percent. Approximately 1 percent of the area is classified as Chernozemic Dark Grays. Less than 3 percent of the soils lack any genetic horizons and are classified as Regosols. Approximately 3 percent have deeply leached profiles developed under forest cover and are classified as Gray Luvisols. Brunisols account for 9 percent of the area, these shallowly leached soils have developed on the very calcareous glacial tills and gravels. About 14 percent of the soils in The Pas area are characterized by poor drainage and are classified as Gleysols. An additional 32 percent of the soils are so poorly drained that peat accumulates to sufficient depth for their classification as Organic soils.

No soils are found in Agricultural Capability Class 1 in The Pas area. Only 3 percent of the soils are in Class 2, the major problem being wetness due to inadequate natural drainage, very slow internal drainage and climate. Approximately 3 percent of the soils are in Class 3. These soils are dominantly lacustrine clay and clay tills with some alluvial soils which have had drainage improvement. Approximately 6 percent of the soils in the map area are in Class 4. The majority of these soils are very stony and occur on glacial till ridge and swale areas. Minor areas of soils are affected by low moisture holding capacity. Around 1 percent of the soils are in Class 5 and may be improved for pasture or forage production. Limitations include low moisture holding capacity, poor drainage, stoniness and rockiness. Class 6 soils occupy 14 percent of the map area and are suitable for use only as native grazing and hay production. Limitations consist of excessive stoniness and rockiness, and poor drainage. About 3 percent of the area is comprised of miscellaneous land types such as bedrock outcropping, recent beaches, flooded marshes or saline flats which have no potential for agriculture.

Organic soils comprise 32 percent of the map area and have little or no value for agriculture in their native state. About 18 percent of the organic soils would be placed in Class 4, 1 percent in Class 5, 12 percent in Class 6 and 1 percent in Class 7, if adequate drainage were provided.

Two percent of the soils are in Class 1 or very good for irrigation. These soils are loam textured and deep with good internal drainage. Less than 1 percent of the soils are in Class 2, having a slight drainage problem. No soils were found in Class 3. Soils in Class 4 are poorly suited to unsuitable for irrigation and comprise 59 percent of the map area. They have problems related to high water tables, low permeability, rapid permeability, shallow depth to bedrock and excess soluable salts.

The mineral soils in the map area range from Class 3 to Class 7 in their capability to grow commercial timber or pulp. Potential productivity on these soils ranges from 6.3 cubic meters per hectare per year to less than 0.8 cubic meters per hectare per year. The basic limitations to production are regional climate, nutritional prob-

lems associated with excessively high levels of lime carbonate in the soils, excessive wetness and droughtiness. Only 5 percent of the soils are in Class 3, 7 percent are in Class 4, and 3 percent in Class 5. About 12 percent have very severe limitations to tree growth because of excessive wetness and shallow depth of soil to bedrock and are placed in Class 6. Soils in Class 7 cover approximately 35 percent of the area. Commercial tree growth on most of these soils is precluded because of excessive wetness. The organic soils in the map area range in capability from Class 6 to Class 7. The majority of these soils, 28 percent of the area are in Class 7, and 3 percent in Class 6 because of excessive wetness.

Most of the problems affecting the use of mineral soils for engineering projects and the implementation of urban and recreation developments are associated with (a) the high content of silt and clay or non-granular materials in the soils, (b) the high shrink-swell potential and slow to very slow permeability of the clayey soils, (c) the very stony conditions and irregular topography of the glacial till soils and (d) the lack of adequate natural drainage and high water tables over large portions of the map area. Organic soils in the map area are very poorly drained and present additional difficulty for engineering use because of high compressibility and low bearing strength.

Present use of the very limited farm land in the study area is cereal grain production and ranching in which livestock is sustained mainly on native forage and some tame hay, reflecting the capability of the soils in the area. The majority of the map area remains as Crown Land utilized mainly in its native state for forestry, wildlife management and for associated recreation activities. The main factors limiting agricultural development and more intensive use of these lands are climate, poor drainage and relative unsuitability of the soils.

Recreation activities within the map area focus on the Clearwater Lake area, which has been set aside as a Provincial Park. The majority of the area is in a native state which provides wildlife habitat and associated recreation activity.

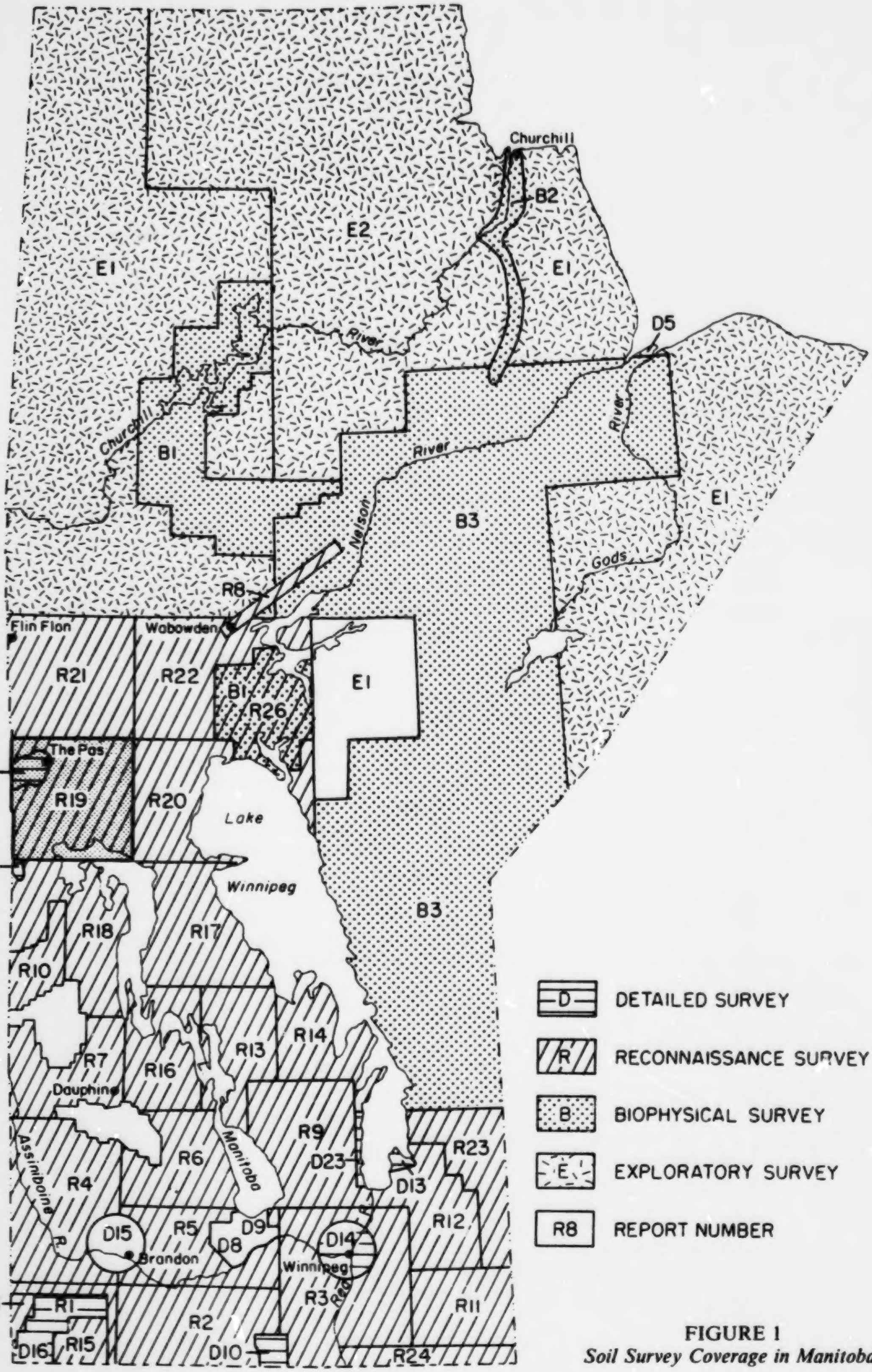

FIGURE 1
Soil Survey Coverage in Manitoba.

TABLE 1
Summary of Soil Survey Coverage for Manitoba

Map Project Designation	Name (Soil Report No.) Status of Information*	Area in Hectares	Map Unit Description†	Scale of Published Map‡	Land Evaluation and Interpretation§
DETAILED STUDIES AND SURVEYS					
D1	Pasquia[1] (No. 11)	57 200	a, b, d	1:63,360[3]	A
•D2	Glenlea Research Station[2]	541	a, b	1:7,920[1]	A
•D3	Morden Experimental Farm[2]	256	a, b	1:12,000[1]	A
•D4	Onanole[2]	768	a, b	1:7,920[1]	U
D5	Soils of the York Factory Area	768	a	1:63,360[2]	–
•D6	McCreary Tile Drain Project[2]	64	a, b	1:5,000	A
•D7	Brandon Experimental Farm[3]	768	a, b	1:7,920[1]	A
D8	Portage Potato Farm[2]	480	a, b	1:4,800[1]	A
D9	Portage la Prairie[1] (No. 17)	113 200	a, b, c	1:20,000[1]	A, I, E, U, R
D10	Morden-Winkler[1] (No. 18)	71 424	a, b, c	1:20,000[1]	A, I, E, U, R
•D11	Deep Lake[2]	1 400	a, b	1:6,000[2]	R
•D12	Thompson Environmental Study[2]	32	a, b	1:1,000[2]	—
D13	Organic Soil Study of Alexander L.G.D.[2]	29 456	a, b	1:63,360[2]	A
D14	Winnipeg Region[1]	280 000	a, b, c	1:20,000[1]	A, E, U, R
D15	Brandon Region[1]	59 600	a, b, c	1:20,000[1]	A, E, U, R
D16	Boissevain-Melita[1] (No. 20)	262 912	a, b, c	1:20,000[1]	A, I, E, U, R
•D17	Carman[4]	55 426	a, b	1:20,000[2]	A, E, R, I
•D18	Orr Lake[2]	20	a, b	1:1,000[2]	—
•D19	Pelican-Rock Lake[4]	14 080	a, b	1:200[2]	A, E, R, I
•D20	West Portage[4]	124 866	a, b	1:20,000	A, I, E, R
•D21	Minnewasta[2]	2 560	a, b	1:20,000[1]	A, E, R, I
•D22	Killarney[2]	4 600	a, b	1:20,000[1]	A, E, R, I
D23	Matlock-Gimli-Riverton[2]	18 400	a, b	1:20,000[1]	A, E, R, I
•D24	Glenboro[3]	5 960	a, b	1:20,000[1]	A, E, R, I
•D25	Sandy Lake[2]	1 720	a, b	1:20,000[1]	A, E, R, I
•D26	Brokenhead[2]	10 432	a, b	1:20,000[1]	A, E, R, I, U
•D27	Rockwood[2]	12 928	a, b	1:20,000[1]	A, E, R, I, U
•D28	Oak Lake[2]	1 293	a, b	1:20,000[1]	A, I
•D29	Bird River[2]	2 560	a, b	1:20,000[1]	A, E, R
•D30	North Shore Lac du Bonnet[2]	2 400	a, b	1:20,000[1]	A, E, R
•D31	Grindstone[2]	8 040	a, b	1:20,000[1]	A, E, R
•D32	Paint Lake[2]	2 880	a, b	1:20,000[1]	A, E, R
•D33	Cranberry Portage[2]	80	a, b	1:5,000[1]	A, E, R
•D34	Dauphin[2]	6 400	a, b	1:20,000	A, E, R, I
•D35	South Riding Mtn.	23 488	a, b	1:20,000	A, E, R
•D36	West Interlake[2]	10 036	a, b	1:20,000	A, E, I, R
•D37	Swan R. Townsite[2]	7 680	a, b	1:20,000	A, E, R, I
•D38	Hadashville-organic[2]	6 475	a, b	1:40,000	A, E, I, R
•D39	Rat River[3]	27 972	a, b	1:40,000	A, E. I, R
•D40	Falcon L.-Brereton L[3]	25 900	a, b	1:20,000	A, E, R
•D41	Quesnel Lake-North Shore[3] Winnipeg River	3 000	a, b	1:20,000	A, E, R
•D42	Duck Mountain[3]	3 036	a, b	1:20,000	A, E, R
•D43	Spruce Woods	26 300		1:40,000	A, E, R
•D44	McGregor[3]	3 910	a, b	1:20,000	A, E, R
•D45	South Central-Escarpment[3]	107 744		1:40,000	A, E, R
•D46	Arborg-Riverton	2 590	a, b	1:20,000	A, E, R, I
•D47	Roblin[3]	4 096	a, b	1:20,000	A, E, R, I
•D48	Flin Flon[3]	4 600	a, b	1:20,000	A, E, R
•D49	St. Anne-La Broquerie[4]	80 065	a, b	1:40,000	A, E, R, I
•D50	Pine Creek-Cypress[3]	2 177	a, b	1:20,000	A, E, R, I
•D51	City of Brandon Planning[3]	2 980	a, b	1:20,000	A, E, R, I
RECONNAISSANCE SURVEYS					
R1	South Western[1] [3] (No. 3)	709 600	d	1:125,000[2]	A
R2	South Central[1] (No. 4)	967 600	d	1:125,000[2]	A
R3	Winnipeg and Morris[1] (No. 5)	1 419 200	d	1:125,000[3]	A
R4	Rossburn and Virden[1] (No 6)	1 372 400	d	1:125,000[3]	A
R5	Carberry[1] (No. 7)	967 600	d	1:125,000[3]	A
R6	West Lake[1] (No. 8)	592 800	d	1:125,000[3]	A
R7	Grandview[1] (No. 9)	689 200	d	1:125,000[3]	A
R8	Nelson River Basin[1] (No. 10)	224 000	b	1:100,000[3]	A
R9	Fisher and Teulon[1] (No. 12)	949 200	a, c	1:100,000[3]	A
R10	Swan River[1] (No. 13)	316 000	a, c	1:125,000[3]	A
R11	South Eastern[1] (No. 14)	749 200	a, c	1:125,000[3]	A, F
R12	Lac du Bonnet[1]	764 800	a, c	1:125,000[3]	A, F, R
R13	Grahamdale[1]	764 800	a, b	1:125,000[3]	A, F, U, R, E
R14	Red Rose-Washow Bay[1] (No. 119)	704 400	a, b	1:125,000[3]	A, F
R15	Boissevain-Melita[1] (No. 20)	299 520	a, b	1:40,000[1]	A, I, E
R16	Ste. Rose[2] (No. 21)	676 705	a, b	1:125,000	A, I, E, R, F
R17	Waterhen[2]	949 600	a, b	1:125,000	A
R18	Swan Lake[4]	599 200	a, b	1:125,000	A
R19	The Pas[1] (No. 22)	791 700	a, b	1:125,000	A, I, E, R, F
R20	Grand Rapids[3]	675 031	a, b	1:125,000	A
R21	Cormorant[2]	920 000	a, b	1:125,000	A
R22	Wekusko[3]	1 400 000	a, b	1:125,000	A
R23	Pointe du Bois[4]	740 000	a, b		

TABLE 1 (Continued)

Map Project Designation	Name (Soil Report No.) Status of Information*	Area in Hectares	Map Unit Description †	Scale of Published Map ‡	Land Evaluation and Interpretation §
R24	Roseau River¹	45 000	a, b	1:63,360	A
R25	Red Deer Lake²	34 860	a, b	1:31,680	A
R26	Cross Lake and Norway House³	615 200	a, b	1:125,000	A
BIOPHYSICAL AND EXPLORATORY SURVEYS					
B1	Lake Winnipeg, Churchill & Nelson Rivers	3 600 000	e	1:250,000 and 1:50,000²	– –
B2	Churchill Transportation Corridor⁴	179 000	f	1:125,000²	–
B3	N.R.I.P. (Northern Resource Information Project) 54C², 54D², SE 1/4 64A⁴, 63P⁴, 53M⁴, 53L⁴, 63H⁴.	11 389 600	f	1:125,000²	–
E1	Surface Deposits & Soils of Northern Manitoba²		g	1:1,267,000²	–
E2	Exploratory Terrain Study of Northern Manitoba and Southern Keewatin, N.W.T.² •		g	1:1,000,000²	–

• Not shown on map.

* Status of Information Code
¹Published Report and Map
²Interim Report and Map
³Preliminary Map and Legend
⁴Field Data Only
⁵Out of Print

† Map Unit Description Code
a-single series and phases
b-series complexes defined as to proportion
c-series complexes undefined as to proportion
d-associations
e-biophysical units (materials and physiography)
f-biophysical units (associations and complexes of associations)
g-regional and physiographic units

‡ Published Map Base Code
¹Photomosaic
²Black and White Line
³Colored Line

§ Interpretations Code
A-Agricultural Capacity
E-Engineering
F-Forestry
I-Irrigation Suitability
U-Urban Planning and Community Development
R-Recreation

PUBLICATIONS AVAILABLE FROM:

Published reconnaissance and detailed soil maps and reports available from: (R1-R20, R24, D1-D3)
Queen's Printer
200 Vaughan St.,
Winnipeg, Manitoba R3C 1T5

Published detailed soil maps and reports available from:
Municipal Planning Branch
1418-405 Broadway Ave.,
Winnipeg, Manitoba R3C 3L6

Published Interim biophysical reports available from:
(54C, 54D, 62P & 52M, 63A & 53D, 53M, 53L, 63P & SE 1/4, 64A)
Surveys and Mapping Branch
Dept. of Renewable Resources and Transportation Services
1007 Century St.,
Winnipeg, Manitoba R3H 0W4

Unpublished preliminary maps with legends and other field data available from:
Canada-Manitoba Soil Survey
University of Manitoba
362 Ellis Bldg.,
Winnipeg, Manitoba R3T 2N2

HOW TO USE THIS SOIL REPORT

This report on the Soils of The Pas area contains a considerable amount of information on the soils, their origin and formation, their classification and their potential for various uses such as dryland agriculture, irrigation, forestry, engineering and urban and recreation development. The report is presented in four parts, Part 1 providing a general description of the area, Part 2 describing the physical factors affecting the formation of the soils, Part 3 dealing with the factors affecting soil development, classification and description of individual soils and Part 4 is an interpretive section evaluating the soils for various uses. The soil map is included in the pocket at the back of the report.

To assist the user to retrieve relevant soil information quickly the following steps are suggested:

Step 1	Locate the area of interest on the soil map.
Step 2	Note the map unit symbols that occur in the area of interest. Complex map symbols use deciles to indicate the proportion of each soil component in the map unit.
Step 3	Consult the map legend at the side of the soil map. Symbols are listed alphabetically giving soil name and dominant texture, soil classification, generalized description of parent materials, dominant drainage and vegetation and a generalized description of topography and stoniness.
Step 4	For interpretive information consult the appropriate section and tables in Part 4. Guides for the evaluation of engineering and recreation uses are found in appropriate Guide Tables in Appendix D.
Step 5	For more specific information on the soils, consult Part 3 where each soil is described in alphabetical order according to soil name. Physical and chemical analysis are presented for representative soils.

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SOILS OF THE PAS AREA

PART 1

GENERAL DESCRIPTION OF AREA

LOCATION AND EXTENT

The Pas map area lies in the west central part of Manitoba between latitudes 53 degrees and 54 degrees N and between longitudes 100 degrees and 102 degrees W. The location of the area mapped with respect to other published soil map areas, is shown in Figure 1. This map area encompasses some 1 278 476 hectares (12 784 sq. km) of which approximately 430 480 hectares (4 304 sq. km) are water. The area includes all of Townships 47 to 57, Ranges 19 to 29; the upper portion of Township 46, Ranges 18 to 29; the lower portion of Township 58, Ranges 18 to 29; and most of Townships 47 to 58, Range 18. This map area contains the L.G.D. of Consol, with the rest of the area being Unorganized Territory.

HISTORY OF DEVELOPMENT

The Fur Trade and Early Exploration

Kelsey was probably the first white man to see the Saskatchewan River in 1690[1]. Some 49 years later Sieur de la Verendrye explored northern Lake Winnipeg and the lower Saskatchewan River. He constructed Fort Bourbon on the present Grand Rapids townsite in 1741. This fort served as a base for exploration on the Saskatchewan, Pasquia, Carrot, Moose and Summerberry rivers. In 1743 Fort Paskoyac was built at the western end of Cedar Lake. A second Fort Paskoyac was built at the present site of The Pas by Chevalier Joseph-Claude Baucher de Niverville between 1750 and 1754. The French exploration of the area was halted when hostilities broke out between France and Britain. British and American businessmen took over the fur trade after the fall of Quebec in 1760. These businessmen later formed the North West Co.

The Northwest Co., used the Saskatchewan River as their primary route for bringing goods in and taking them out of the area. At this time the Hudson's Bay Co., used the Saskatchewan River as only one of several fur routes. Increased use of the Saskatchewan River stemmed from the Red River colony's increased administrative and agricultural roles. With the advent of the flat bottomed sternwheelers in 1870-80 the Saskatchewan River gained more importance as a shipping route. The Hudson's Bay Co., had the "Manitoba", "Marquis", "Northcote" and the "Northwest" sternwheelers constructed above Grand Rapids, while the "Commissioner" was one of the independently owned sternwheelers plying the Saskatchewan River. By the First World War, logs were transported down the Carrot and Saskatchewan Rivers.

Government sponsored explorations used the Saskatchewan River; in 1858 when Henry Hind and John Fleming carried out a reconnaissance survey of the Saskatchewan River and the north shore of Cedar Lake, in 1859 Simon Dawson investigated the lower Saskatchewan area, in 1870-71 William Butler surveyed for a possible C.P.R. rail route, and in 1892 J.B. Tyrell surveyed the geology of the area.

The Pas (Fort Paskoyac No 2) was a very strategic spot on the Saskatchewan River, for the Indians and Metis tended to frequent this spot. The Pas developed even more when Reverend Henry Budd established a Anglican Mission (Cumberland or Devon Mission) in 1840, with the school following later in 1847.

The area around The Pas (levee's of the Carrot and Pasquia) had an agricultural capability, for vegetables, grain and livestock. Local produce helped to service the fur trade needs. The first permanent agricultural settler (Joseph Constant) came from Three Rivers in 1800. In 1915 the agriculture potential was developed by a group of French Canadian settlers from St. Nicholas-Ste. Hyacinthe; Quebec. Flooding for three consecutive springs forced the settlers to give up farming.

The Hudson Bay Co., fur trading post at Moose Lake was established around 1790, in an area which the Indians frequently fished. This post captured a lot of the fur trade which would have went to independent traders. The next major development in this area took place in 1880 when Reverend J.R. Settie established the Anglican Mission at Moose Lake. Further development occured in 1917 when Mr. T. Lamb successively raised cattle in the Moose Lake Settlement. Both private concerns and the Indians raised cattle.

---

[1] This section extracted from the "Pilot Land Use Planning Project", 1975. Agriculture Section by W.K. Harper.

Forestry

In 1910 the Finger Lumber Co., (later renamed The Pas Lumber Co.) had set up a sawmill and a planning mill in The Pas and used timber cut within the Saskatchewan watershed. Their products were sold locally, shipped south or sent north. The Pas started to grow after the Finger Lumber Co. set up residences for its employees. In 1966 the Manitoba Government signed an agreement with CFI, which gave the company timber cutting rights to a large area of forested lands in northern Manitoba. Construction on the CFI forestry complex began in 1967. This immediately created jobs and resulted in a rapid increase in population of The Pas area. In 1969 the CFI complex began producing pulpwood and lumber. In 1972 the Company went into receivership and in 1974 it became a Crown Corporation, Manitoba Forestry Resources Ltd. (MFR).

Agricultural Development

1. Pasquia

Interest in land settlement in the Pasquia Area began around the turn of this century and a series of river lots were laid out north and south of the Carrot River[2]. The first study of reclamation for land settlement in the Pasquia Area was made in 1910 by W. Ogilvie, a Dominion Land Surveyor who analysed the soils from this area. There were several other reclamation investigations conducted which eventually led to the conclusions in G. G. Horsey's report of 1923 that the area had great agricultural potential. The feasibility of its development was largely dependent on the needs of more farm land in the west for which at that time there was little need. On the basis of Horsey's report, no further consideration was given to the land reclamation or disposal of land in the Pasquia Area by the Dominion Government. In 1930, Crown Lands of Manitoba were transferred to Provincial control and the Pasquia came under the administration of the Provincial Government.

During the dry 1930's a major portion of the marshy area between the Carrot and Pasquia rivers was dry and was used for hay and pasture by settlers of the Carrot River levee. Some of this land was cultivated for grain production. The effort of the settlers to obtain land sales and the need for new lands for Post-War Rehabilitation influenced the Provincial Government to re-examine the reclamation of this area. A reconnaissance soil survey conducted in 1946 revealed that the soils were dominantly poorly drained, peaty, and subject to periodic floods. Some of the area was unsuitable for agriculture because of stoniness or salinity, but a large block of soils were considered suitable for farming if surface drainage could be provided and if the area could be protected from floods.

Following the soil survey, investigations of reclamation possibilities were undertaken, first by the Lands Branch of Manitoba and later by engineers of Prairie Farm Rehabilitation Branch (PFRA). These investigations resulted in the Canada-Manitoba Agreement of 1953 authorizing the construction of dikes, canals and other engineering works required for reclamation of the area. These engineering works included: the diversion of the Pasquia River into the Carrot River; diking along the diversion ditch and along the south side of the Carrot River; construction of drainage canals and roads within the project area; and the installation of two pumping stations.

Initially, the Pasquia drainage system was designed as a gravity flow system. This system is no longer functional because of a change in the hydrology of the area brought about by the Squaw Rapids Dam 176 kilometres up-river and the Grand Rapids Dam 154 kilometres down-river from the Pasquia Area. Since the original gravity drainage system became non-functional, pumping became necessary. Very little maintenance of the system was carried out. This resulted in many of the ditches becoming silted in and overgrown with willows and weeds. In some cases, additional ditching was added.

Improper drainage resulted in extensive crop losses, due mainly to the lateness of spring planting and fall harvesting. In many instances, soil preparation and seeding operations were retarded because of water on the land. Crops were not ready for harvest until mid-September or later and were susceptible to waterfowl and blackbird depredation, fall rains, and early snow. Because of crop losses, many farmers took off-farm employment. This in turn affected the quality of farming. In order to develop viable farm units, proper spring drainage was required so that the water would be off the land 2 weeks earlier. In 1971 the provincial government implemented improvement to existing drains and pumping capacity.

Although the total area of the Pasquia Land Settlement Project contains approximately 228 320 hectares (142,700 acres), only 121 136 hectares (75,710 acres) are under intensive agriculture.

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[2] This section extracted from the "Pilot Land Use Planning Project", 1975. Agriculture Section by W.K. Harper.

2. Saskeram

Interest in land settlement in the Saskeram area occurred around the turn of this century. A series of river lots were laid out north and south of the Carrot River. These lots were sold to homesteaders prior to World War I. Following disastrous floods of 1915, 1916 and 1917, the Dominion Government withheld Crown Land in the area from homesteading or sale except for the river lots south of the Carrot River. During the dry 1930's farmers from drought stricken southern Manitoba came and squatted on Crown Lands in the Pasquia Area.

In 1942, the area north of the Carrot River excluding river lots became the Saskeram Fur Rehabilitation Block. During the 1950's the Government purchased all but one parcel of private land north of the Carrot River, but made lots available to Pasquia farmers on a Crown Land lease basis (5 and 10 year leases).

In 1963, Order in Council 1463/63 designated the area north of the Carrot River lots as the Saskeram Wildlife Management Area. This was done primarily to prevent overhunting, encroachment by agriculture and to partially mitigate the loss of wildlife habitat due to flooding of the Grand Rapids forebay.

3. Rahls Island

Immediately east of the town of The Pas is an area known as Rahls Island. In the past much of this area was susceptable to spring flooding by the Saskatchewan River but due to hydrologic changes in the river and the addition of drainage ditches and controls, flooding is no longer a serious problem. Approximately 645 hectares (1,586) acres (23.4 percent) of the total area is utilized for crops and farming production. Although the remainder of the area is not developed, much of the land is used to graze cattle. Native hay is cut yearly in amounts relative to the amount of water on the land.

POPULATION

The total population for The Pas map sheet in 1979 was approximately 11,434. This represents a population density of 2.3 people per square mile. Eighty four percent of the people (9,600)[3] live in the town of The Pas with the remaining 16 percent (2,211 people)[4] scattered throughout the Pasquia land settlement project, Moose Lake settlement, Moose Lake, The Pas and Big Eddy Indian Reserves.

TRANSPORTATION AND MARKETS

The town of The Pas is linked to southern Manitoba by PTH No. 10, by Canadian National Railway, by daily land based air service at Guy Hill and by water based service at Grace Lake (Figure 2). The Pas is a principal gateway and distributing center for northern Manitoba. A new highway running north from Winnipeg has now opened an alternate route to the north via Ponton and Thompson. PTH No. 10 extends north to Flin Flon, with connections to Snow Lake, Wabowden and Thompson. Provincial highway 283 connects The Pas with various points west into Saskatchewan.

A gravel road across The Pas Moraine now connects the communities of Grand Rapids and Easterville with The Pas, good secondary gravel roads service the Pasquia farming settlement. Winter roads service outlying communities such as Moose Lake.

The Pas is the marketing centre for the Pasquia farming settlement. Most of the grain produced is handled by local dairy operations or elevator in The Pas. Some produce, such as rapeseed is shipped to various Saskatchewan points via highway 283. Animals ready for market are shipped south by rail or truck transport.

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[3] 1979 M.H.S.C. population of The Pas as found in "Report on Manitoba Communities", by Dept. of Economic Development.

[4] Figure arrived at by compilation of township populations found in the 1971 census.

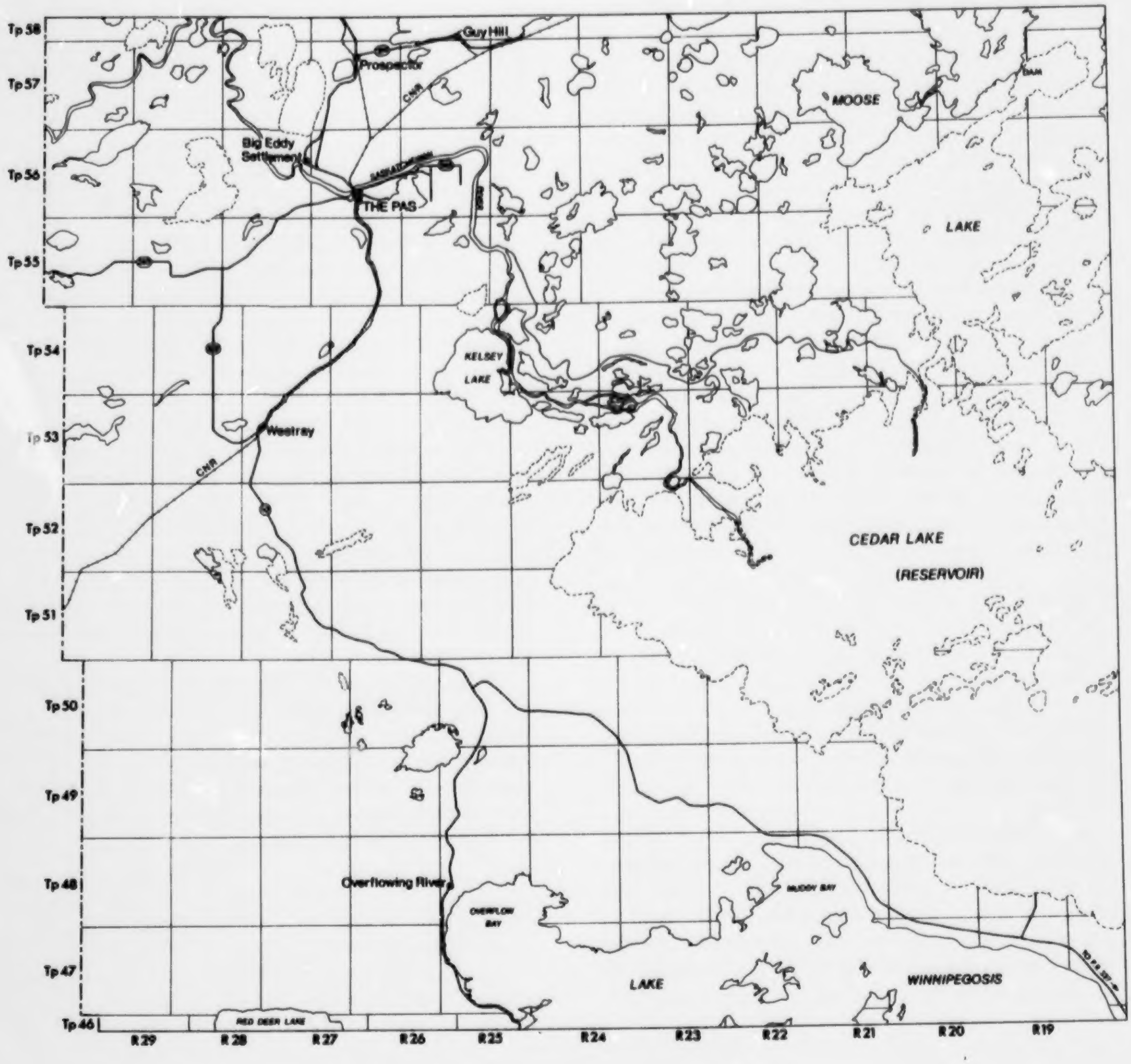

FIGURE 2
Towns and Main Transportation Routes in The Pas Area.

PART 2

FACTORS AFFECTING SOIL FORMATION

The principal factors affecting soil formation are climate, vegetation, parent material, relief and drainage. The type of soil formed at any one place is dependent upon the interaction of these factors, the length of time they have been operative, and the modifications resulting from the work of man.

GEOLOGY AND SOIL PARENT MATERIAL

A surface mantle of unconsolidated materials covers the bedrock formations throughout most of The Pas map area. These unconsolidated materials are derived from the action of the continental ice sheets which completely covered Manitoba during the Pleistocene Epoch. The ice sheets gouged out, picked up and transported huge quantities of materials from the bedrock formations over which they passed. When the ice sheets melted, the rock materials were deposited as glacial drift in various forms. These drift deposits, along with areas of recent alluvium and organic deposits constitute the major parent materials from which the soils have been developed.

Geology of the Underlying Rocks

The bedrock formations underlying The Pas are shown in Figure 3. The bedrock formations underlying this area are Paleozoic limestones and dolostones of the Silurian and Devonian formations with some Lower Cretaceous sandstone and shales of Mesozoic age occurring in the southwest corner of the map area. These limestones and dolostones contribute to the calcareous materials that make up the surface deposits of a large part of the area. The bedrock formations trend in a northwest-southeast direction and generally dip in a westerly direction, so that the oldest rocks are exposed in the northeastern portion of the area.

Glacial History

The entire area was glaciated during the last Wisconsin stage[5]. Little is known about the early stages of glaciation, chiefly because evidence of older events were destroyed by later ice movements. The ice covering the area, however, went through a series of advances and retreats during the late Wisconsin stage. The latest movement was generally from a northeasterly direction (eastern lobe) and formed The Pas moraine approximately 10,800 years B. P. Following a local readvance beyond The Pas moraine, the ice melted and glacial Lake Agassiz covered the low-lying ice-free portion of the area. The Pas moraine marks the oldest ice movement in the area.

The Pas moraine extends from about 48 kilometres north of The Pas, along the Big Bog south to the north shore of Lake Winnipegosis and east to Long Point on Lake Winnipeg. The front of the moraine forms a southwest-facing escarpment some 46 m high in the Interlake area, about 30 m high along Highway No. 10, 48 km south of The Pas, approximately 7.5 m high at The Pas, and about 23 m high north of The Pas in the Clearwater Lake area. The area above the escarpment, a poorly drained fluted till plain 1.5 to 10 kilometres wide, slopes gently to the north and east. The fluting is almost perpendicular to the moraine front and, in places, terminates at the escarpment (Figure 4). The asymmetric profile together with the distribution of bedrock outcrops suggest that The Pas moraine comprises an accumulation of till along the front of a bedrock escarpment (Craig 1965). The striae and fluting at right angles to the moraine front above the escarpment indicate the direction of the ice flow and that the till accumulation could well mark the position of the ice front.

Later, the level of Lake Agassiz dropped in stages due to the opening of new outlets. This is represented by several Lake Agassiz beaches at successively lower elevations. These beaches are probably best developed at the edge of moraines. At the front of The Pas moraine, for example, 3 successive levels of beaches occur at approximately 12 m intervals.

Due to glacial rebound, the Saskatchewan River abandoned the Minago Channel, and the present course, through Grand Rapids into Lake Winnipeg, was established.

According to drill data the Saskatchewan delta area is dominated by recent alluvial deposits up to 18 m thick. These alluvial sediments are generally underlain by lacustrine silts and clay up to 26 m thick. Between the lacustrine deposit and limestone bedrock, variable thicknesses of glacial till have been found.

Lake Agassiz drained about 8,000 years ago and subsequently vegetation was established and peat development began in the area.

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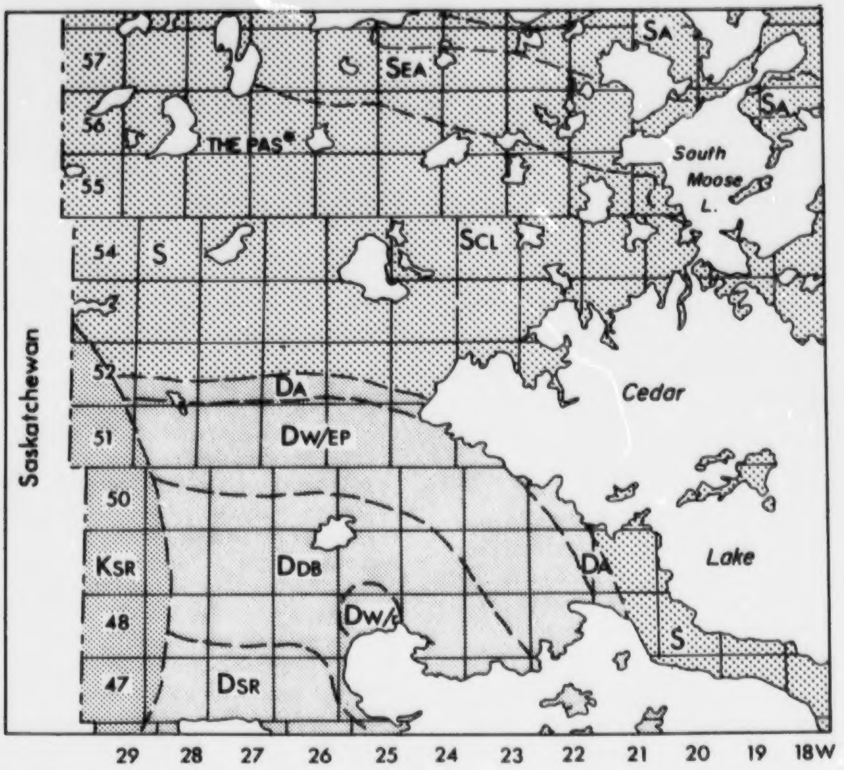
[5] This section extracted from, C. Tarnocai's, Glacial History, Surface Materials and Permafrost section in the "Pilot Land Use Planning Project, The Pas Special Area, Manitoba" March 1975.



MESOZOIC

Lower Cretaceous

KSR Swan River Formation (0-105m): sandstone, in places glauconitic; kaolinitic shale, minor lignite. May include some non-marine Jurassic beds in the north. Also includes channel and/or karst fill within Paleozoic outcrop belt. Locally missing from outcrop sequence due to non-deposition.

PALEOZOIC

Upper and Middle Devonian

DSR Souris River Formation (65-95m): sequence of basal red shale (First Red Beds), argillaceous micrite, high-calcium micritic limestone, and upper dolomite in northern area, complex facies of limestone and dolomite to the south.

Middle Devonian

DDB Dawson Bay Formation (45-60m): sequence of basal red shale (Second Red Beds), bituminous dolomite grading upward to micritic limestone to brachiopod biomicrite (high-calcium); red to grey fossiliferous calcareous shale; highly fossiliferous coral stromatoporoid limestone (high-calcium), locally dolomitized.

DW/EP Elm Point Formation: high-calcium limestone biomicrite (platform facies). Winnipegosis Formation: lower member - dolomitized platform facies (grades laterally to DEP); upper member - thin inter-reef bituminous laminates or thick reffal carbonates (Dw/r). Total thickness 12-105m.

DA Ashern Formation (5-12m): dolomitic shale and argillaceous dolomite, red to greenish grey; local basal breccia.

SILURIAN

S Interlake Group (50-105m): Atikameg (A), East Arm (EA) and Cedar Lake (CL) Formations; micritic, fossiliferous, stromatolitic and biostromal dolomites with several sandy/argillaceous marker beds.

Reference: Geological Map of Manitoba; Map 79-2
Manitoba Mineral Resources Division, 1979

FIGURE 3
Bedrock Formations Underlying The Pas Area.

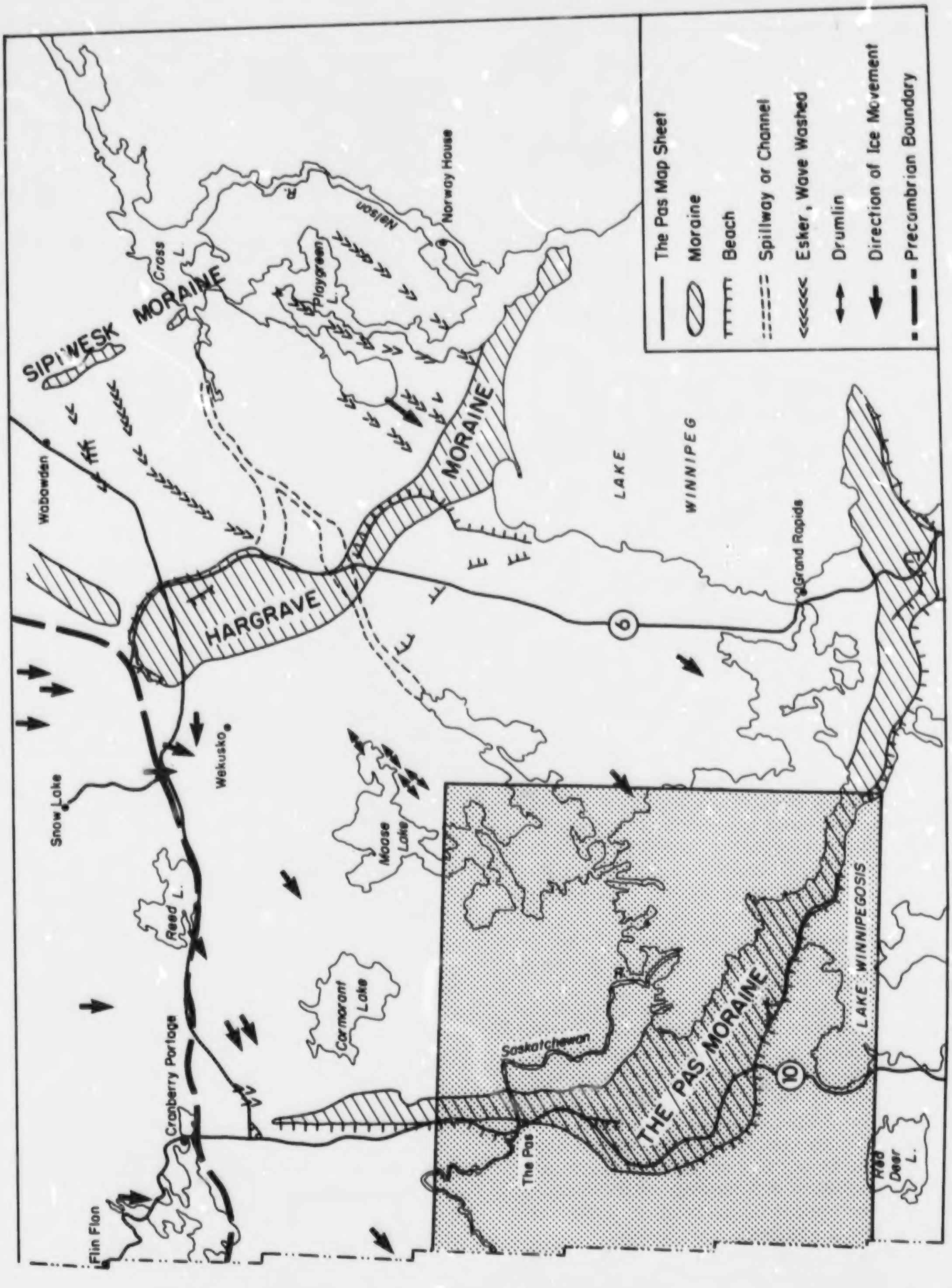


FIGURE 4
Glacial Map Showing the Direction of Ice Movement and the Associated Landforms in the Area North and West of Lake Winnipeg.

SURFACE DEPOSITS AND PHYSIOGRAPHIC AREAS

The distribution of surface deposits (Figure 5) and their division into physiographic areas are shown in Figure 6. The terrain of The Pas area lies entirely within the Manitoba Plain of the Interior Continental Plain of Canada. The area mapped may be divided into 3 major sections on the basis of surface deposits; the Westlake Plain, the Cedar Lake Plain and the Cumberland Lake Lowland.

The Westlake Plain section (D2) is divided into the Westlake Till Plain Subsection (D2.1) and the Overflowing River Lowland Subsection (D2.4). The surface deposits within the Westlake Till Plain Subsection (D2.1) adjacent to Lake Winnipegosis consist of thick water-worked ground moraine, thin ground moraine over bedrock and thin outwash deposits. The gently undulating glacial till of the ground moraine is dominantly loamy textured, extremely calcareous, stony material derived from underlying Paleozoic limestones and from granitic rocks of the Precambrian Shield. A small amount of clay textured till is present in this unit. Deep organic soils dominate the depressions between the upland ridges. In this area the soils developed on the extremely calcareous till are dominantly Eluviated Brunisols and those on the moderately calcareous clay textured till are dominantly Gray Luvisols.

The Overflowing River Lowland (D2.4) occupies the southwest corner of the map sheet. It is a level to very gently sloping area dominated by shallow and deep organic deposits. A few areas of loamy or clayey textured till appear as scattered upland islands. Along the rivers and creeks gently sloping alluvial levees are present. The lower portion of the Overflowing River Lowland has a number of beaches, some organic covered with others raised above the surrounding organic deposits. Elevations range from about 255 masl at the Manitoba Saskatchewan border to 305 masl at the foot of The Pas Moraine.

Extensive areas of organic soils in the Overflowing River plain are developed on moderately well decomposed fen peat and on undecomposed to moderately well decomposed forest peat. Most of the forest peat deposits have significant surface layers of fibrous Spaghnum present.

The peat deposits in the Big Bog area, are deep. The areas adjacent to open water usually consist of deep, moderately well decomposed fen deposits. Isolated occurences of deep fibric Sphagnum deposits, also are present.

The Cedar Lake Plain section in this map sheet has three subsections; the Moose Lake Plain (D4.1), The Pas Moraine (D4.2), and the Summerberry Lowland (D4.3).

The Pas Moraine Subsection (D4.2) stands out as a topographic high 5 to 28 kilometres wide, running in a northwesterly direction from the southeast corner of the map area where it forms the divide between Cedar Lake and Lake Winnipegosis. It swings north through the Saskatchewan Delta to a position north of The Pas. At the town of The Pas the escarpment is only about 5 km wide and has been cut through by the Saskatchewan River. Although the moraine is comprised of fairly thick fluted accumulations of till, the elevation of the escarpment is accentuated by significantly higher bedrock elevations to the east and north, than to the south and west[6]. In cross section the crest of the escarpment is on the southern and western edges where the elevation drops abruptly from more than 305 masl to the alluvial deposits at 258 masl or to 255 masl in the lower portions of the Overflowing River Lowland. This portion of the moraine is characterized by an extensive beach complex and series of eroded terraces 1/2 to 1 km in width paralleling the crest. On aerial photographs a distinct fluted or drumlinoid pattern is evident on the surface of the moraine at right angles to the front, but on the ground these ridges have very low relief. The crests of these ridges are from 1/2 to 1 km apart and are separated by elongated depressional areas of similar width. The fluted ridges are dominantly imperfectly and poorly drained, the intervening swales are poorly to very poorly drained. At higher elevations on the moraine the till is generally composed of extremely calcareous loamy material; at elevations below 274 masl complexes of the extremely calcareous loam till and the less calcareous clay textured till occur.

The poorly to well sorted beach deposits along the crest of the moraine are characterized by Brunisolic soils. The soils developed on the extremely calcareous till are classified in the Brunisolic Order, and those on the moderately calcareous clay textured till are classified in the Luvisolic Order. The majority of the organic soils are developed on shallow, moderately decomposed forest and or fen peat. The shallow fen peats are dominantly Terric Mesisols. Only a few deep, patterned fens were observed in this subsection and these soils were classified as Typic Mesisols and Hydric Mesisols.

The Moose Lake Plain Subsection (D4.1) is located on the eastern side of the map sheet, with a small portion of the area found south of Clearwater Lake. Thin deposits of water worked loamy high lime till on limestone bedrock islands characterize much of this area. In some areas the till has a 0.3 to 1.0 m cap of clay. It is difficult to determine whether the clayey unit is solely lacustrine in origin or whether it has been modified subse-

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[6] Klassen, R.W., 1966. Surficial Geology of the Waterhen-Grand Rapids Area, Manitoba. Paper 66-36. Geological Survey of Canada, Dept. of Energy, Mines and Resources.

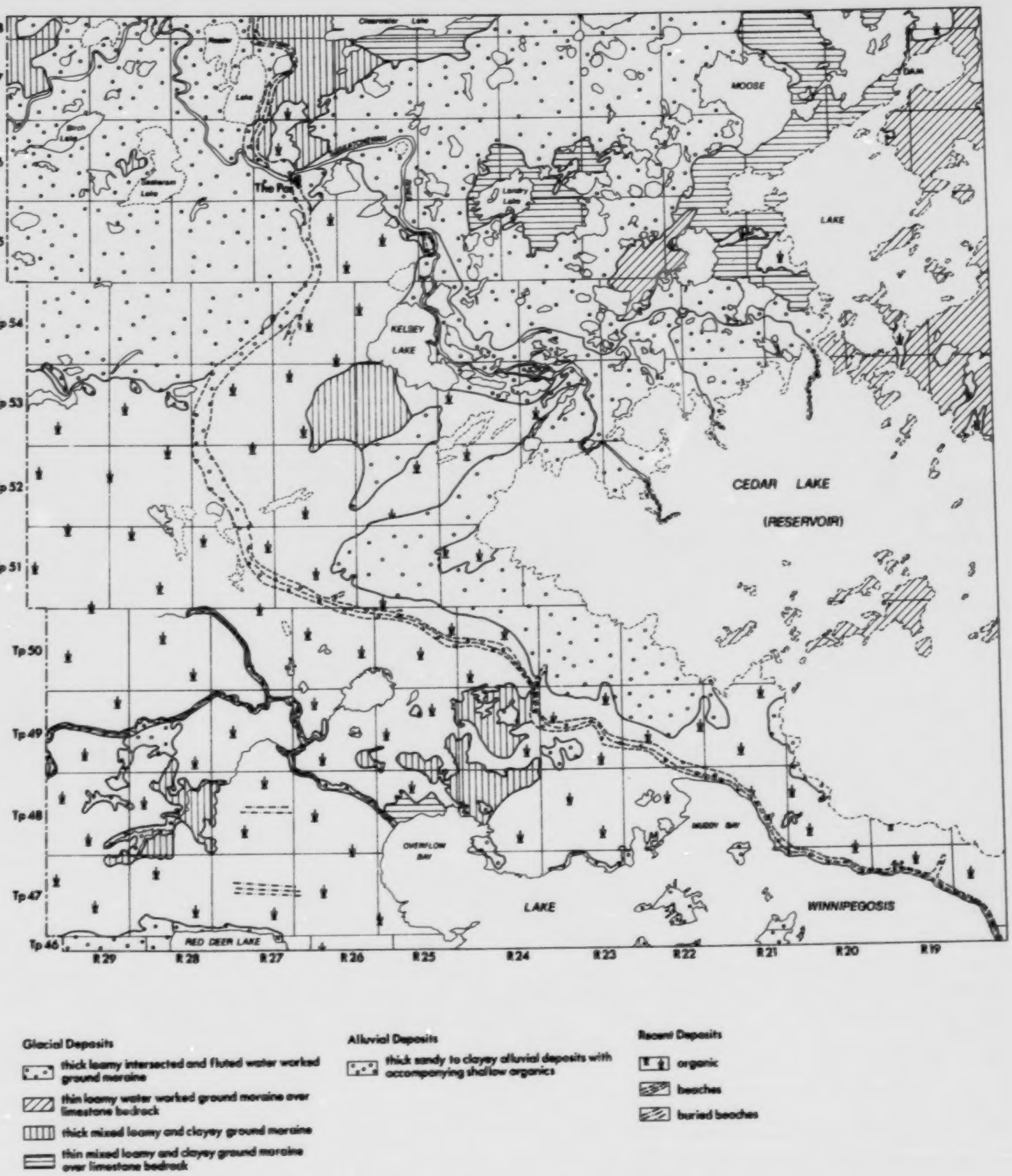
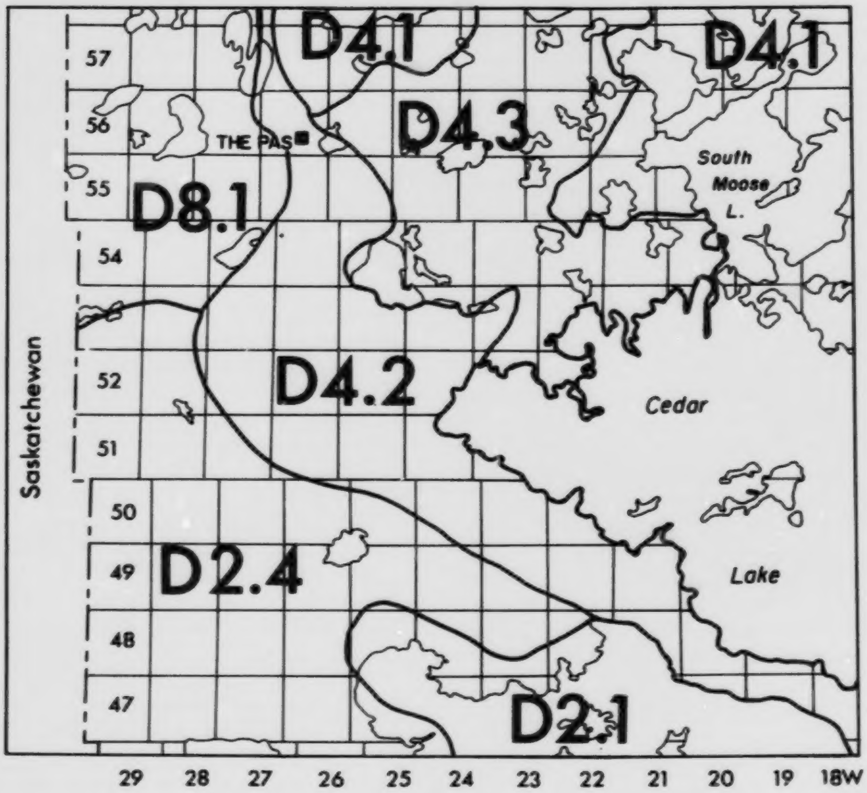


FIGURE 5
Distribution of Surface Deposits in The Pas Map Area.



DIVISION	SECTION	SUB SECTION
Manitoba Plain	D2 Westlake Plain	.1 Westlake Till Plain .4 Overflowing R. Lowland
	D4 Cedar Lake Plain	.1 Moose Lake Plain .2 The Pas Moraine .3 Summerberry Lowland
	D8 Cumberland Lake Lowland	.1 Saskatchewan Delta

FIGURE 6
Physiographic Subdivisions in The Pas Map Area.

quently by an overriding glacier[7]. In this subsection both the lacustrine clay and the clayey till seem to be present. The lacustrine clay areas tend to occur near the lakes.

For the most part the organic soils found in this area tend to be shallow forest and fen peats (Terric Mesisols). The high lime till deposits are characterized by Brunisolic soils and the soils developed on lacustrine clay and clay till are dominantly Luvisolic.

The Summerberry Lowland Subsection (D4.3) is a smooth, nearly level area of recent alluvial deposits laid down by the flooding of the Saskatchewan, and Summerberry Rivers and associated tributary streams. Elevation in this subsection ranges from 253.5 to 257 masl. The average eastward drop is 9 cm per kilometre. The Pas moraine separates the Summerberry Lowland from the Saskatchewan Delta. Local relief is provided by the levees built up by the rivers and intermittent streams. The most prominent relief features in this unit are till islands which outcrop in scattered locations throughout the delta.

Natural drainage is slow due to the extreme flatness of the area and the damming effect of the levees along the rivers and streams. Without artificial drainage the removal of surface water would be minimal by downward percolation, lateral seepage and by evaporation. Except for the Rahl's Island area which is presently being used for agriculture this area is reserved and being managed for wild life.

The recent alluvial deposits of this area range in texture from sandy loam to clay with somewhat coarser textures occurring on the levees. Finer textured deposits are common in the adjacent depressional sites, which are subject to more frequent periodic flooding. The soils of this area are poorly to imperfectly drained; the former being dominant.

The soils mapped on the better drained levees consist mainly of Gleyed Cumulic Regosols. The poorly drained alluvial soils are mainly Rego Gleysols carbonated phase developed on dominantly medium to fine textured recent alluvial deposits. Much of the poorly drained alluvium is mapped as a peaty phase in which 15 to 40 cm of moderately well decomposed fen peat occurs on the surface. The dominant organic soil in this area is a Terric Mesisol, underlain by loamy to clayey textured lacustrine and alluvial deposits. These soils consist of 40-160 cm of moderately well decomposed fen peat over mineral substrate. The till islands in this area are characterized by Brunisolic soils on the high lime till materials and Luvisols on the less calcareous clayey textured till.

The Cumberland Lake Lowland (D8) has one subsection, the Saskatchewan Delta (D8.1). The Saskatchewan Delta is a smooth nearly level area of recent alluvial deposits laid down by flooding of the Saskatchewan, Carrot, Pasquia Rivers and tributary streams. Elevations range from about 262 masl at the Manitoba-Saskatchewan boundary to about 257 masl at the foot of The Pas moraine near The Pas. The average eastward drop is 9 cm per kilometer. Local relief is provided by the levees built up by the rivers and intermittent streams. Like the Summerberry area the most prominent relief features in this unit are a number of till island which outcrop in scattered locations throughout the area.

Natural drainage is slow due to the extreme flatness of the area and the damming effect of the levees along the rivers and streams. Without artificial drainage the removal of surface water by downward percolation, lateral seepage, and by evaporation is minimal. The area between the Carrot and Pasquia Rivers and extending to the Saskatchewan border has been drained by ditches so that with the aid of pumps and protection by dikes, much of it is under cultivation. The Saskeram area north of the Carrot River is still under natural drainage and has only limited agricultural use for native hay and grazing. The Saskeram area is being managed for wildlife.

The soils in this area are similar to those in the Summerberry Lowland, dominantly peaty Rego Humic Gleysols, shallow organic soils and Gleyed Cumulic Regosols.

RELIEF AND DRAINAGE

The principal relief and drainage systems for The Pas Map area are shown in Figure 7.

The Pas Moraine stands out as a topographic high 5 to 30 kilometres wide running in a northwesterly direction from the southeast corner of the map area where it forms the divide between Cedar Lake and Lake Winnipegosis. It swings north through the Saskatchewan Delta to a position north of The Pas. At the town of The Pas the escarpment is only about 5 kilometers wide and has been cut through by the Saskatchewan River. In cross section the crest of the escarpment is on the southern and western edges where the elevation drops abruptly from more than 304.8 masl to the alluvial deposits of the delta at about 258 masl or to about 256 masl in the lower portions of the Overflowing River area. Ground moraine and organic deposits forming the surface of the moraine slope to the north and east at a rate of about 1.9 metres per kilometre. A distinct fluted pattern is evident on the surface of the moraine at right angles to the front (ie on aerial photographs), but on the ground these ridges have very low relief. The crests of these ridges are from 0.5 to 1

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[7] Klassen R.W. 1966. Surficial Geology of the Waterhen-Grand Rapids Area, Manitoba Paper 66-36 Geological Survey of Canada, Dept. of Energy, Mines and Resources.

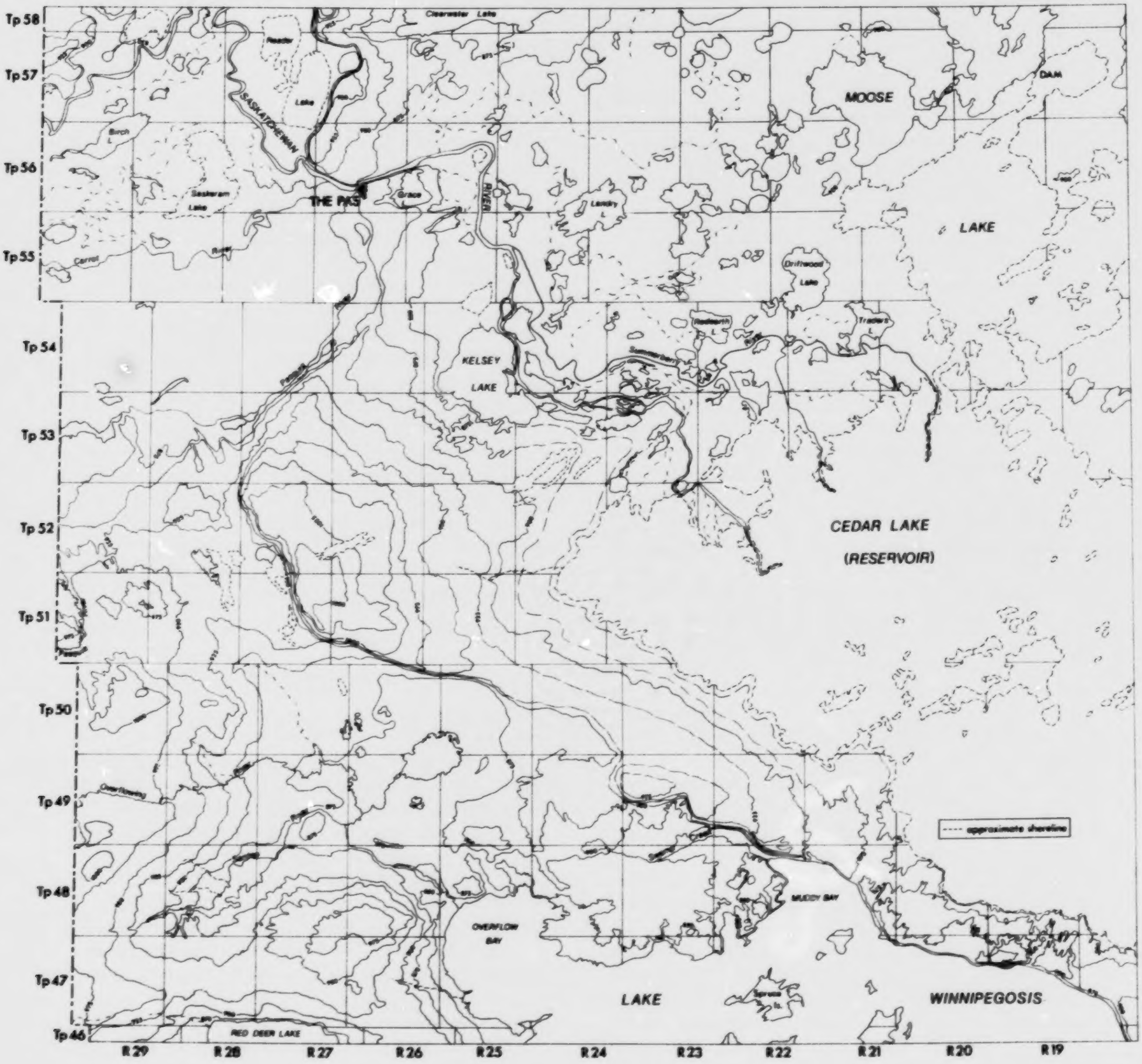

FIGURE 7

Principal Relief and Drainage Systems for The Pas Map Area.

km apart and are separated by elongated depressional areas of similar width.

The surface drainage is poorly developed over the map area. Waters in the Saskatchewan River Delta area drain into Cedar Lake Resevoir via the Saskatchewan River and its associated tributaries (Pasquia River, Carrot River, Summerberry River) and ditches. The various rivers, creeks and streams feeding the Saskatchewan River carry a great deal of suspended sediment. They either originate in or flow through fine textured lacustrine sediment and peatlands. These waters are shallow and slow flowing. The large sediment load they carry contribute a considerable amount of deposition in the form of alluvium during flood stage.

The Overflowing River Lowland drains into Lake Winnipegosis via the Overflowing River, Santon River, Swamp Creek and associated creeks and channels.

Despite its prominence in the landscape, The Pas Moraine has very poorly developed drainage for a number of reasons. No rivers or creeks exit from this upland; it is essentially flat despite its surface pattern of riges and swales; and the runoff from the ridges slowly collects in adjoining swales or in the large peatlands.

CLIMATE

In relation to world wide climatic conditions The Pas map area lies within the region designated as Dfb[8], a region located in the center of the continent at a great distance from the oceans and beyond their moderating effect on temperature. As a result summer temperatures are higher, winter temperatures are lower and the annual temperature range much greater than the world average for this latitude.

The meteorological station at The Pas airport is the only available recording station in the map area. Tabulated temperature and precipitation data from this station is found in Table 2[9]. To supply an interpretation of climatic conditions for areas where such information is lacking, data derived from the Williams-Hopkins agroclimatic estimates model estimating mean monthly temperature and several other derived variables for 3 sites in The Pas map sheet are shown in Tables 3 and 4[10].

Precipitation

The Pas region has a subhumid climate with a definite summer maximum of precipitation and a mean total precipitation of about 491 mm (Table 2). Approxmiately three quarters of the total precipitation falls as rain during April to October interval with the remainder falling as snow during the five winter months from November to March[11], February and March, with the least snowfall, are the driest months at The Pas station. July, with a mean rainfall of 79.2 mm is the wettest month.

Other Climatic Factors

Several estimated climatic variables for 3 points within The Pas area are presented in Tables 3 and 4. The growing season above 5.5 degrees C refer to the period from the time when the annual curve of daily mean temperature rises above 5.5 degrees C in the spring to when it falls below 5 degrees C in the fall. The value of 5.5 degrees C is significant as it is the daily mean temperature below which vegetative growth of common cultivated crops practically ceases. The growing season varies from 165 to 167 days. The start of the grow-

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[8] Koppen, W. and Geiger, Handbuch der Klimatologie, Bond I, Teil C, Geduder Borntreger, Berlin, 1936.

[9] Temperature and Precipitation Tables for Prairie Provinces, 1941-1970. Canada Dept. of Transport, Meteorological Branch, Toronto, Ontario.

[10] Williams-Hopkins. 1968 Agroclimatic estimates for 1180 points on The Canadian Great Plains. Agrometeorological Section, Plant Resource Inst., Can. Dept. Agr., Ottawa.

[11] For these averages, the depth of water resulting from melting newly fallen snow has been taken as one-tenth of the depth or thickness of the snow fall.

TABLE 2
Mean Monthly Temperature, Total Precipitation and Snowfall at The Pas[1]

Station and Element	Geographic Location Elevation (m.a.s.l.)	 West Longitude	 North Latitude	Monthly Jan	 Feb.	 Mar.	 Apr.	 May	 June	 July	 Aug.	 Sept.	 Oct.	 Nov.	 Dec.	 Yearly
The Pas[2]	271.5	101°15'	53°49'													
Meandaily °C Temp.				−22.0	−18.3	−11.1	0.6	9.2	14.7	18.3	16.7	10.3	4.2	− 7.8	−16.9	−0.3
Meandaily Max. °C				−17.5	−12.8	− 4.4	6.1	14.7	20.6	23.9	22.2	15.6	8.9	− 4.4	−13.3	5.0
Meandaily Min. °C				−27.0	-23.8	-16.9	−5.6	2.5	8.9	12.5	10.9	5.0	−0.6	−11.7	−21.9	−5.6
Total precipitation (mm)				25.1	22.6	22.6	26.7	41.4	58.7	79.2	65.3	59.9	29.2	35.1	25.9	491.7
Snow (cm)				24.9	22.6	21.8	14.0	3.6	T	0.0	0.0	1.8	9.9	32.0	25.9	156.5

[1] Data for The Pas obtained from Temperature and Precipitation Tables for Prairie Provinces, 1941-1970, Environment Canada.

[2] These averages are based on the period of record of 50 years.

TABLE 3
Estimated Climatic Variables for Three Points in The Pas Map Area[1]

		Geographic Location		Frost - 0°C			Frost - 2°C (killing)			Growing Season -5°C			Degree Days (5.6°C)
Point No.	Elevation m.a.s.l.	West Longitude	North Latitude	Average Last Spring Frost (0°C)	Average First Fall Frost (0°C)	Average Frost Free Period (days) (0°C)	Average Last Spring Frost (−2.2°C)	Average First Fall Frost (−2.2°C)	Average Frost Free Period (days) (−2.2°C)	Date of Start (5.5°C)	Date of End (5.6°C)	Period (days) (5.5°C) (5.6°C)	May 1 – Sept. 30
435	855	100°23'	53°11'	May 31	Sept. 12	104	May 17	Sept. 24	130	Apr. 30	Oct. 12	165	1415
436	866	100°49'	53°11'	May 31	Sept. 12	104	May 17	Sept. 23	129	Apr. 29	Oct. 12	166	1328
437	871	101°16'	53°11'	May 31	Sept. 12	104	May 17	Sept. 23	129	Apr. 28	Oct. 12	167	1433

[1] Williams/Hopkins. Agroclimatic Estimates for 1180 points on the Canadian Great Plains. Agrometeorology Sections Plant Reserach Institute, Research Branch, Canada Dept. of Agriculture, Ottawa, June, 1968.

ing season is generally around April 28, ending approximately on October 12th.

Degree days above 5 degrees C express the length and warmth of the growing season in a single figure. In The Pas area the degree days vary from 1328 to 1433 for the period May 1st to September 30th.

The average frost free period[12] is 104 days. The last spring frost occurred on the average, on May 31, while the average first fall frost occurred on September 12. The killing frost free period correlates more closely with the actual cropping season and is about 129 to 130 days. On the average, the date of the last spring killing frost is May 17th, and for the first fall killing frost is September 23.

Soil Temperature

Soil temperature is related to aerial climate, but the relationship is affected by soil depth, texture, soil water content, surface cover (vegetation, snow), landscape position (slope and aspect), and man's manipulation. Soil temperatures are generally cooler in soils with finer texture, higher moisture contents, and with less exposure to the sun, such as on eastern or northern slopes. Soil temperature follows a wave pattern in response to seasonal air temperature changes, the response being greater and more rapid near the surface with a considerable lag in time and amplitude with depth.

Characteristics of the soil thermal regime measured for soils in The Pas region are given in Table 5. The location of these sites in relation to established Soil Climatic Regions in Manitoba is shown in Figure 8.

Soils in Relation to Climate

Climate has two major efforts upon soil formation. It is the most important factor influencing the type of natural vegetation under which the soils are formed, and it affects the weathering process whereby rocks, minerals, and organic matter are broken down to become soil material. Soils in The Pas area of Manitoba are weakly weathered because of cool temperatures, long winters, and low rainfall.

The entire map area is classified as 3.1-3.2 fe/b according to the Soil Climatic Map of Canada[13]. This term indicates a cold to moderately cold Cryoboreal climate, with a growing season of between 120 and 220 days, and a growing season degree-days figure of between 555 and 1250. The actual growing season at The Pas ranges from about 104 to 130 frost free days. The moisture regime is aquic, indicating soils are saturated for

TABLE 4
Estimated Mean Maximum and Minimum Temperatures (°C) for Three Points in The Pas Map Area*

	Geographic Location			Monthly												Yearly
Point No.	West Longitude	North Latitude	Mean Daily	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
435	100°23'	53°11'	Max°F	−15.6	−11.1	−3.9	6.7	16.1	20.0	24.4	22.8	16.1	8.9	−3.3	−11.7	5.6
			Min°F	−25.5	−23.3	−16.7	−4.4	3.3	8.9	12.2	10.6	5.6	0.0	−10.6	−20.8	−5.0
436	100°40'	53°11'	Max°F	−15.6	−11.1	−3.3	7.2	16.1	20.0	24.4	22.8	16.1	8.9	−3.3	−11.7	6.1
			Min°F	−25.5	−23.3	−16.7	−4.4	3.3	8.3	12.2	10.6	5.6	−0.6	−10.6	−20.8	−5.0
437	101°16'	53°11'	Max°F	−15.0	−11.1	−3.3	7.2	16.1	21.1	24.4	23.3	16.1	9.4	−3.3	−11.1	6.1
			Min°F	−24.9	−23.3	−16.7	−4.4	3.3	8.3	12.2	10.6	5.6	−0.6	−10.6	−20.2	−5.0

* Williams/Hopkins. 1968. Agroclimatic estimates for 1180 points on the Canadian Great Plains. Agrometeorological Section, Plant Resource Inst., Can. Dept. Agr., Ottawa.

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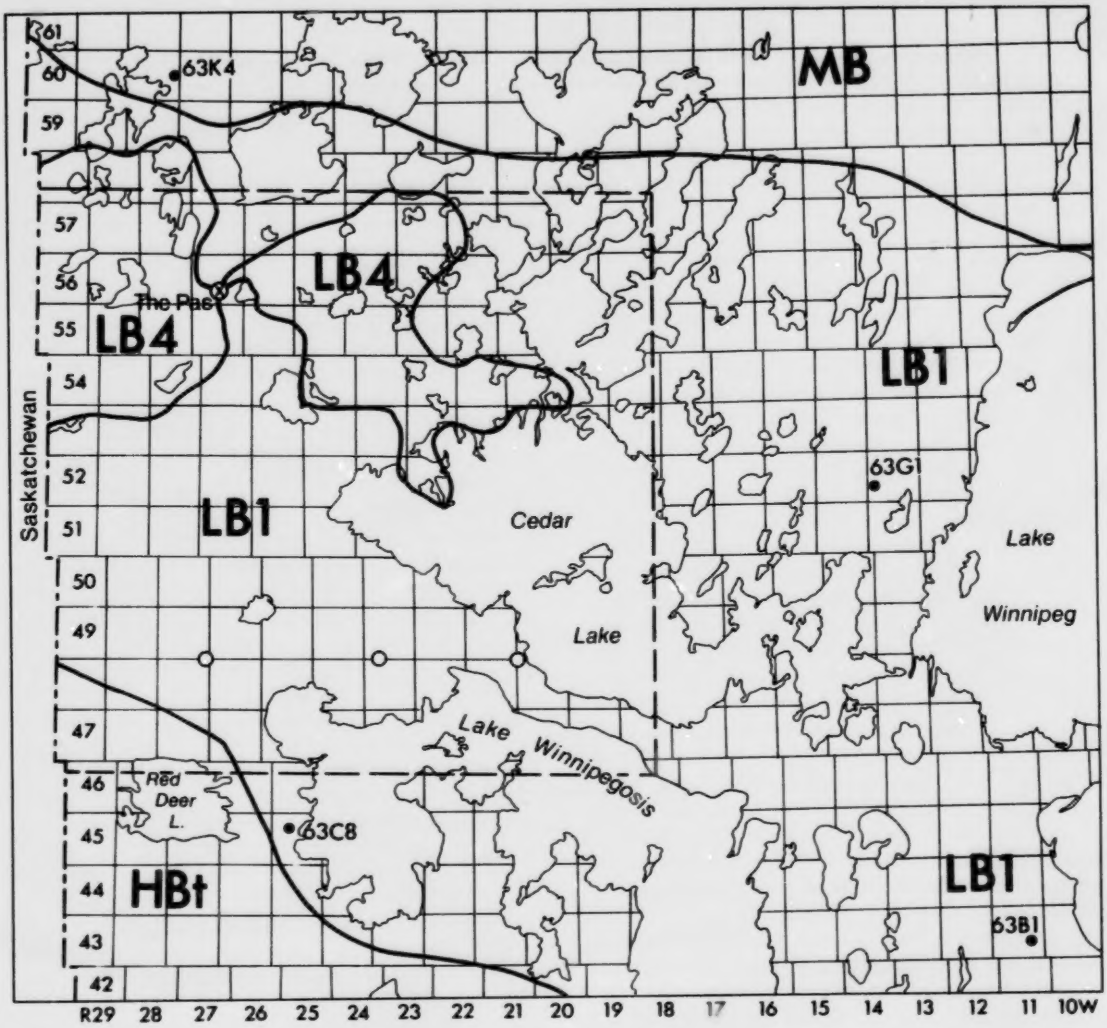
[12] Frost occurring on or before July 15th was classified as spring frost and frost on or after July 16th was considered a fall frost.

[13] Clayton, J.S. et al., 1977 Soils of Canada.



Climatic Subregions

MB	**Mid Boreal**
LB1	**Low Boreal**
LB4	**Low Boreal**
HBt	**High Boreal temperate**

——— soil climatic boundary

⊗ meteorlogical station

● soil temperature sites

○ Williams and Hopkins Climatic Points

— — The Pas map sheet

FIGURE 8
Soil Climatic Subregions of The Pas Map Area.

TABLE 5
Actual Site specific Soil Climatic Data and Site Characteristics[1] of a Number of Soil Temperature Sites Characterizing the Climatic Sub Region in and around The Pas Map Sheet

						Date 0°C						Topography		
Climatic Sub Region	Map Symbol	Site	Depth cm	Soil Mean Ann.	Temp. Mean Summer	Spring	Fall	Soil Name (Profile Type)	Texture	Drainage	Vegetation	Elevation (m)	% Slope	Aspect
High														
Boreal	HBt	620 2	20	4.6	12.8	90	333	Fairford	loam	moderately	jack pine	265	0.5	NE-E
Temperate		Gypsumville	50	5.0	11.1	88	356	(E.E.B.)		well	aspen, black			
		C12-13-10W	100	5.1	9.4	82	20				spruce			
		63B 1	20	4.6	12.0	95	341	Cedar	clay	well	aspen	245	0.5	N
		Devils Lake	50	4.8	10.4	95	361	Lake		moderately	black		0.5	
											spruce			
		SW14-43-11W	100	4.7	8.5	92	24	(O.G.L.)		well				
Low	LB	63 G 1*	20	4.1	9.6	95	352							
Boreal		Buffalo						Limestone	loam	well	black	275	0-0.5	–
		Lake	50	4.1	8.5	95	4	Point			spruce, ash			
		SW32-52-13W									pine			
		63C8	20	4.4	11.6	94	341	Atikameg	loam	well	black	260	0	–
								(E.E.B.)			spruce			
		Dawson												
		Bay 2	50	4.5	9.7	92	362				jack pine			
		SE21-46-												
		25W	100	4.5	7.8	83	30							
								Wabowden	clay	well	black	275	0	–
Mid	MB	63K4	20	3.1	9.3	109	340	(SZGL)			spruce			
Boreal														
		Wanless	50	3.2	7.3	116	363							
		SE24-60-												
		27W	100	3.2	5.0	121	33							

* bedrock at 90 cm depth

[1] Mills, G.F., C. Tarnocai, and C.F. Shaykewich. Characteristics and Distribution of Soil Temperature Regimes in Manitoba, Canada. Proc. Man. Soil Sci., Soc., 1977.

moderately long periods, and the moist unsaturated regime is subhumid to humid. This is indicative of a slight moisture deficit within the growing season of from 2.5 to 12.7 cm. Besides the broad regional soil climatic classifications produced for the Soil Climates of Canada map, a more specific map of climatic regions and subregions, has been produced for Manitoba[14]. These climatic units have been delineated on the basis of aerial and soil climatic information as well as the distribution of the dominant soil types and vegetation zones in the province. The Pas map area is delineated into two distinct climatic subregions as illustrated in Figure 8. The High Boreal-temperate (HBt1) climatic subregion occupies the southwestern corner of the map area, while the Low Boreal climatic subregion covers the rest of the map area. The Low Boreal (LB4) climatic subregion occupies the low lying alluvial and organic soils of the Saskatchewan River Delta, and the Summerberry Lowland physiographic areas.

The largest portion of the map area falls into the Low Boreal (LB1) climatic subregion.

Selected climatic data for these subregions are given in Table 5.

The precipitation values for both subregions are similar, however the higher air and soil temperatures in the more southerly High Boreal temperate zone results in significant soil and vegetation differences. In the Low Boreal subregion where temperatures are cooler the amount of water removed from soil through evapotranspiration is less, more of the moisture is available for downward infiltration and leaching resulting in slightly deeper profiles in well drained sites on similar soil parent material. While such differences in soil morphology are not normally employed in differentiating soil types, the differences in soil climate and vegetation growth response on the other hand do represent sufficient reason for soil type differentiation.

The High Boreal temperate climatic subregion is a transitional zone between the grassland vegetation of the prairies to the south, and the boreal forest region to the north. Soils here are dominantly slightly leached, Dark Gray Chernozems, along with Brunisols and organic soils.

The Low Boreal zone is characterized by mixed deciduous-coniferous forest vegetation. Soils are somewhat more leached, consisting mainly of Luvisols, Brunisols, Gleysols, and organic soils. The organic soils in this region tend to have a greater surface cover of Sphagnum moss and support stunted black spruce and tamarack trees.

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[14] Soil Climatic Regions of Manitoba. Canada-Manitoba Soil Survey, unpublished data.

VEGETATION

The area covered by The Pas map sheet lies within the northern part of the Boreal Forest Region in the Manitoba Lowland Section (B15), as delineated by Rowe[15].

Throughout this area tree cover becomes nearly continuous. Apart from the Saskatchewan Delta the land is covered with coniferous forest. White spruce (*Picea glauca*) characterizes the better drained sites, while on the poorly drained sites, black spruce (*Picea mariana*) predominates. Black spruce and larch (*Larix laricinia*) are dominant tree species in bogs.

A history of extensive fires throughout The Pas area has prohibited establishment of the black spruce climax forest. Consequently mature, well developed stands with thick feather-moss carpets are rare. Primary species successional to fire on well drained sites are aspen (*Populus tremuloides*), jack pine (*Pinus banksiana*) and white birch (*Betula papyrifera*). Without further disturbance they are replaced by white or black spruce. White spruce is the secondary successional species on south facing slopes, around lake shores, and on the well drained alluvial deposits throughout the Saskatchewan Delta. Aspen and black spruce are the successional species on imperfect to poorly drained sites.

Bogs and fens occur throughout the map area. Vegetation varies from the black spruce bog, which is a continuous forest of stunted trees with a dense floor of ericaceous shrubs and mosses to sedge fens. Bogs occur in depressional areas where the main source of water is precipitation, consequently acid conditions prevail. Black spruce and larch make up the tree strata with Labrador tea (*Ledum groenlandicum*) and baked apple-berry (*Rubus chamaemorus*) dominating the shrub layer. The ground cover of forbs, grasses and mosses include horsetails (*Equisetum* spp.), sedges (*Carex* spp.) bog cotton (*Eriophorum* spp.) (*Sphagnum* spp., *Hylocomium splendens* and *Pleurozium schreberi*).

Fens receive much of their water from upland runoff. Therefore these waters are nutrient rich and able to support a rich flora. Treeless fens often occur in areas characterized by extreme wetness. In such areas it is probable that infilling of ponds and depressions by organic residues has occurred in relatively more recent times than treed bogs. In general, however, as one proceeds northward in The Pas sheet such fens tend not to be so open, they become increasingly more treed with stunted black spruce and tamarack. Open fens have a ground cover of sedges (*Carex* spp.) and brown mosses (*Drepanocladus* spp.). Somewhat better drained open fens, have a shrub cover of willows (*Salix* spp.) and swamp birch (*Betula glandulosa*).

In the Saskatchewan Delta a vegetative anomaly occurs in that there are large non-forested areas on the poorly drained flood plain deposits. Here the regional climax vegetation has not established due to intermittent flooding over the years. Marshes occur on the poorly drained mineral deposits throughout the Saskatchewan Delta. The dominant species are sedges, reed grass (*Phragmites communis*), bulrushes (*Scirpus* spp.) and cattails (*Typha latifolia*). Clumps of willows, swamp birch and aspen occur on some of the better drained sites. On the levees the native vegetation consists of aspen, balsam poplar (*Populus balsamifera*), elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), box-elder (*Acer negundo*), white birch (*Betula papyrifera*), spruce and balsam fir (*Abies balsamea*).

Eastern white cedar (*Thuja occidentalis*), showy mountain ash (*Sorbus decora*) and mountain maple (*Acer spicatum*) are observed at a number of locations along The Pas moraine between Cedar Lake and Lake Winnipegosis.

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[15] Rowe, J.S. 1972. Forest Regions of Canada. Dept. of Environment, Canadian Forestry Service. Publication No. 1300.

PART 3

SOILS

The soils that have developed under the influence of the soil forming factors described in Part 2 exhibit physical characteristics which reflect their environment. Through observation of these characteristics, it is possible to classify soils in accordance with the processes involved in their formation. Such a classification scheme permits the grouping of soils into natural units. The recognition of these units is dependent on the study of soil profiles and soil development.

SOIL DEVELOPMENT

The principal factors of climate, vegetation, relief and drainage acting upon unconsolidated soil parent material are responsible for the development of soil. The type of soil formed in any one place is dependent upon the interaction of these factors and upon the length of time they have been active.

The soils of this map area have developed in the boreal forest, under subhumid continental climatic conditions. Forest litter and herbaceous plants provide the organic matter added to the soil. Coniferous species dominate the tree canopy in most of The Pas map area. Deciduous trees and herbaceous species are abundant in the Red Deer Lake area. Deciduous forest litter is rich in materials that are readily decomposed. Consequently, the A horizons of most of the soils in the Red Deer area are high in organic matter and thus dark in color. Under these conditions the Chernozemic Dark Gray soils develop and account for 2 percent of the land area mapped.

Under the same climatic conditions soils show differences due to both texture and mineralogical composition of the parent material. In The Pas area Brunisolic soils (15 percent) have developed on calcareous glacial tills and gravels; the result of the extremely calcareous nature of the till parent material and the droughty condition of the gravels because of very low clay content. The clay, iron, and aluminum in these soils are irregularly translocated with the result that Ae horizons are often weakly developed broken or absent. Brunisolic soils appear to represent a stage of soil development between Regosols and Luvisols.

The Gray Luvisol soils mapped in The Pas area constitute 5 percent of the total land area mapped. These soils exhibit a distinctive eluvial (Ae) and illuvial B horizons in which silicate clay is the main accumulation product. They are found on clayey lacustrine, and till deposits that have a much lower calcium carbonate level.

Regosolic soils (4 percent) are confined to flood plain areas of the Saskeram and Summerberry Lowland.

Gleysolic soils (24 percent) have developed in poorly drained areas on a variety of parent materials with textures ranging from sand to clay. Saturated conditions are reflected in soils by dull gray colors and/or iron mottling. These soils are invariably covered by a thin mantle of either mixed peat or fibric moss peat.

Organic soils (50 percent) have developed on poorly to very poorly drained areas. The Pas area with a cold to moderately cold subhumid climate provides very suitable conditions for development of peat deposits. Because these soils are of vegetal origin, they reflect the succession of vegetation deposited, and provide a record of the changing ecology in the peatlands. These soils are developed from three types of material.

1. Forest peat (10 percent) forms under poorly drained conditions. These sites are under the influence of nutrient rich groundwater. The vegetation occuring on these sites is productive black spruce, feathermoss, black spruce - Laborador Tea - feathermoss, productive black spruce - tamarack - sedge - feathermoss, and tamarack - sedge communities. The dominant peat former is feathermoss with some *Sphagnum* spp. and varying amounts of ericaceous shrubs, woody species and sedges. Forest peat is usually moderately decomposed, contains a significant volume of coarse to woody fragments and is usually medium to slightly acid in reaction.

2. Fen peat (28 percent) forms under very poorly drained sites which are also influenced by nutrient rich groundwater. The vegetation occuring on these sites is of sedges - brown mosses, and sedges - brown mosses - swamp birch communities. The dominant peat formers are sedges with minor amounts of mosses, reeds, grasses and shrubs. Fen peat is very uniform, non-woody, moderately well decomposed and usually medium acid to mildly alkaline in reaction.

3. Sphagnum peat (12 percent) forms under poorly and very poorly drained sites which are isolated from nutrient rich groundwaters and thus the water's supplied only by rain. The vegetation occuring on these sites is that of the Sphagnum - black spruce - Laborador Tea, or Sphagnum - Laborador Tea commu-

nities. The dominant peat formers are Sphagnum mosses with minor amounts of feathermosses and ericaieous shrubs. This material may contain some inclusions of spruce or tamarack wood. Sphagnum peat is relatively undecomposed, quite uniform and usually extremely to slightly acid in reaction.

THE SOIL PROFILE

A soil when viewed in vertical cross-section, consists of soil layers called soil horizons. The main or master horizons have been designated by the letters L,F,H, for organic layers and A,B,C for mineral horizons. Lower case suffixes are used to indicate the type of master horizons and arabic numerals are used when further division into subhorizons are required. If the soil profile is developed from non-conforming parent materials, Roman numeral prefixes are used to indicate lithologic changes. Table 6 presents a hypothetical soil profile showing all principal horizons. The master horizon symbols and lower case letter suffixes are defined in more detail in Appendix B.

The A and B horizons are a reflection of the genetic forces operating on the parent material and together they form what soil scientists call the solum of the soil. No simple definition of master horizons is possible since there are so many different kinds. In general, A horizons or surface layers are subjected to the greatest amount of weathering and leaching or organic matter accumulation. The B horizons, lying immediately below the A horizon contain most of the material leached from A horizons or have had other changes brought about by soil forming forces. The C horizons represent the relatively unweathered underlying geological deposits from which the sola have developed. Examples of the use of soil horizon nomenclature are given in Figure 9.

SOIL CLASSIFICATION

The soils of The Pas area are classified according to the Canadian System of Soil Classification[16], a hierarchical system in which the classes are based upon an evaluation of the properties of real bodies of soil. Such a classification system is called a taxonomic system in which various classes are defined on measurable soil properties that reflect processes of soil formation and environ-

TABLE 6

A Hypothetical Soil Profile Showing All Principal Horizons

L, F, H Organic debris lodged on soil developed under forest, usually absent on soils developed under grasses.	L	Loose leaves and organic debris, largely undecomposed
	F	Organic debris, partially decomposed or matted
	H	Well decomposed organic matter, original structures indiscernible
A Horizons of maximum biological activity and maximum eluviation (removal of materials dissolved or suspended in water, or both).*	Ah	A dark colored horizon with a high content of organic matter mixed with mineral matter
	Ae	A light colored horizon of maximum eluviation. Prominent in Luvisolic and Podzolic soils; faintly developed or absent in Chernozemic and Brunisolic soils
	AB	Transitional to B, but more like A than B. Sometimes absent
B Horizons of illuviation (of accumulation of suspended material from A) or of maximum clay accumulation, or of blocky or prismatic structure, or both.*	BA	Transitional to A, but more like B than A. Sometimes absent
	Bm	Alteration due to hydrolysis or oxidation to give a change in color or structure as in Chernozemic soils
	Bmy	Like Bm but strongly disrupted by frost action
	Bt	Maximum enrichment of clay minerals as in Luvisolic soils
	Btj	Insufficient clay enrichment to qualify for Bt
	Bn	Maximum development of prismatic structure as in Solonetzic soils
	Bfh	Maximum enrichment of iron and organic matter as in Podzolic soils
	BC	Transitional to C
C The soil parent material. Occasionally absent, i.e. soil building may have extended to a stratum other than bedrock, and of distinctly different character from that in which the solum is found.	Cg	Denotes strongly gleyed horizons as in Gleysolic soils
	Cca	Accumulation of calcium carbonate
	Csa	Accumulation of soluble salts other than calcium carbonate
	Ck	Denotes presence of carbonate
	Cz	Frozen layer
Consolidated bedrock	R	

+ It should be noted that not all of these horizons occur in any one soil profile.

* A and B represent the Solum, the genetic soil developed by soil-forming processes.

Source: Principles and Practices of Commercial Farming, 1977.

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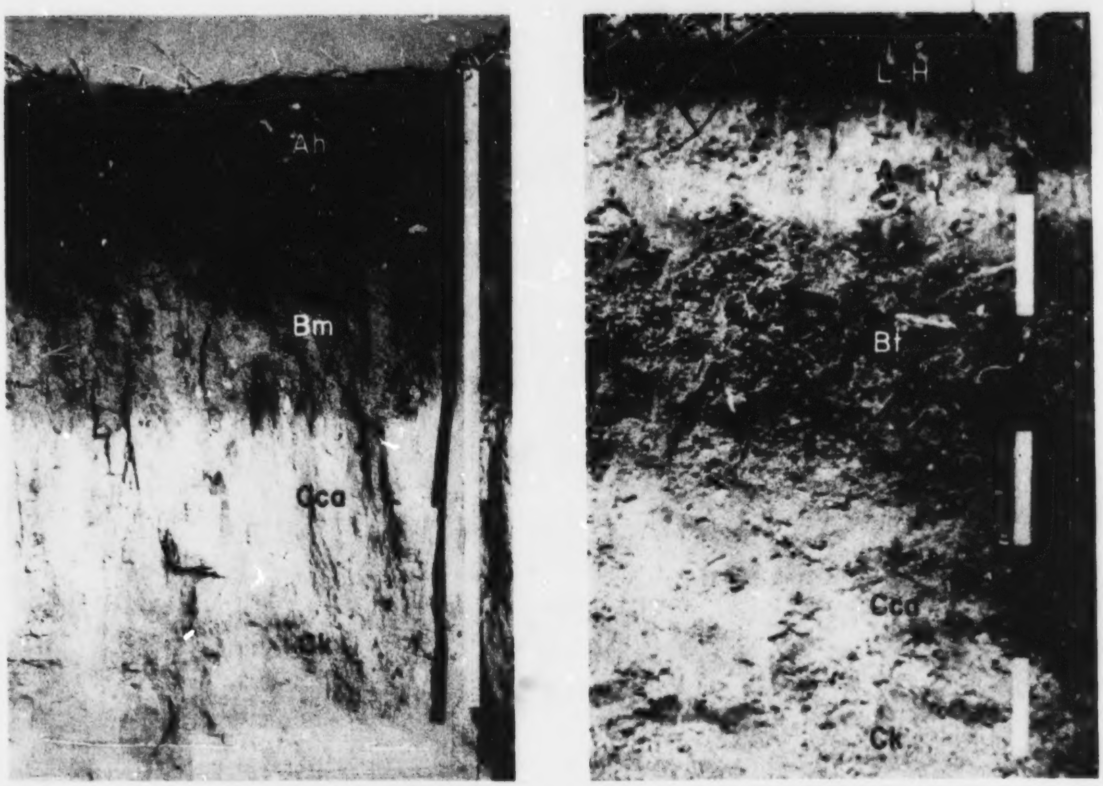
[16] The System of Soil Classification for Canada. 1974 Revised Canada Soil Survey Committee.



Black soil profile showing subdivision into soil horizons.

Gray Luvisol soil profile showing subdivision into soil horizons.

FIGURE 9
Examples of the use of soil horizon nomenclature.

mental factors. Some of the characteristic soil profiles found in The Pas are found in Figure 10.

The system organizes soil information into various classes at five different levels of generalization as follows:

Order - Classes at the order level are defined in terms of broad generalizations that reflect the soil environment and the effects of dominant soil forming processes. There are nine orders of soils in the Canadian System.

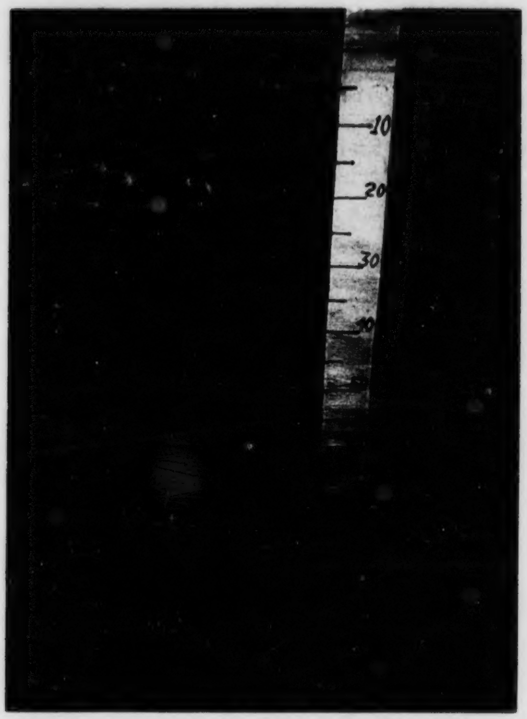
Great Group - Great groups are classes formed by the subdivision of each Order. Great Groups reflect differences in strength of dominant processes or a major contribution of a process in addition to the dominant one. For example, in Luvic Gleysols the dominant process is considered to be gleying, but clay accumulation in the B horizon of such soils is also a major process. There are twenty-eight great groups in the system.

Subgroup - Subgroups are formed by subdivision of each great group. Subgroups are differentiated on the basis of kind and arrangement of horizons that indicate: conformity to the central concept of the great groups, Orthic; intergrading toward soils in other orders, eg. Gleyed Luvisol or special features such as calcium carbonate in B horizons. There are a total of 186 subgoups in the system.

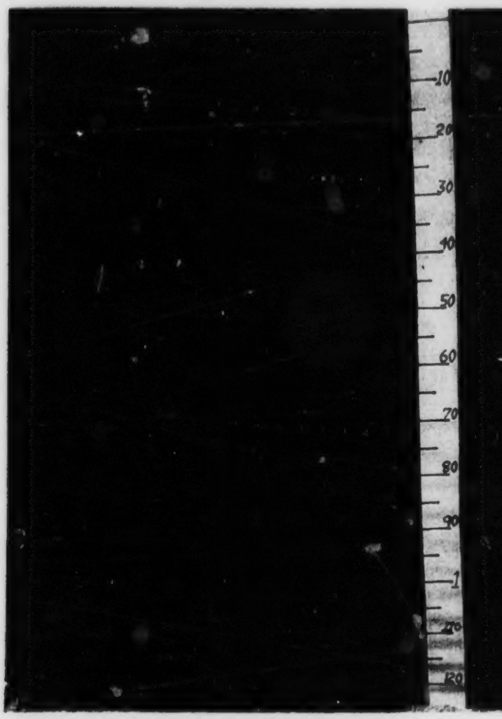
Family - Classes at the family level are formed by subdividing subgroups. Families within a subgroup are differentiated on the basis of parent material characteristics such as texture and mineralogy, soil climatic factors, and soil reaction. The number of soil families are undetermined and grow with the progress of soil survey.

Series - The basic unit in the system is the soil series. A soil series is defined as a naturally occurring soil body such that any soil profile within the body has a similar number and arrangement of horizons, whose color, texture, structure, consistence, thickness, reaction and composition are within a narrowly defined range. Soil series are very often subdivided into phases. Phases of soil series are based on variations of such features as degree of erosion of the profile, topographic change, stoniness, or salinity.

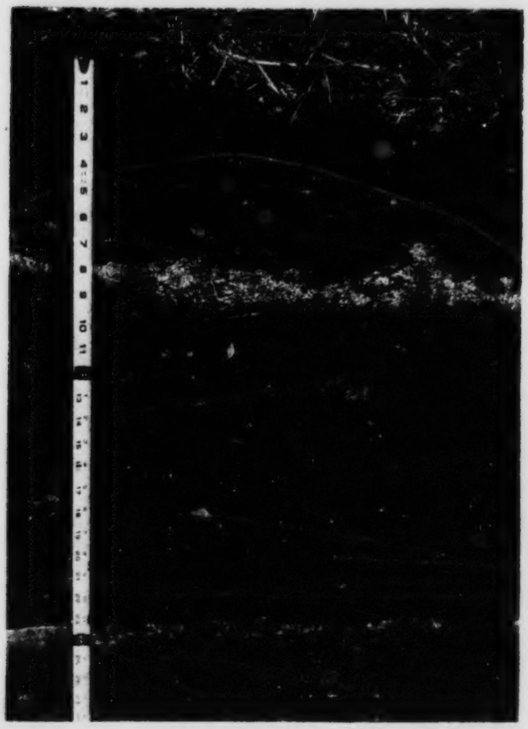
Pedon - For sampling purposes, the minimum size of a soil body representing a Soil Series has



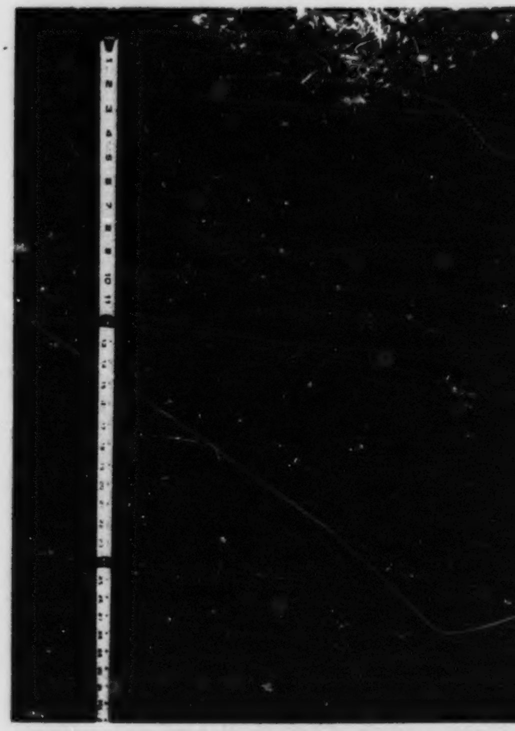
Soil profile of Warpath clay till. A Gleyed Gray Luvisol developed on moderately to strongly calcareous clay till.



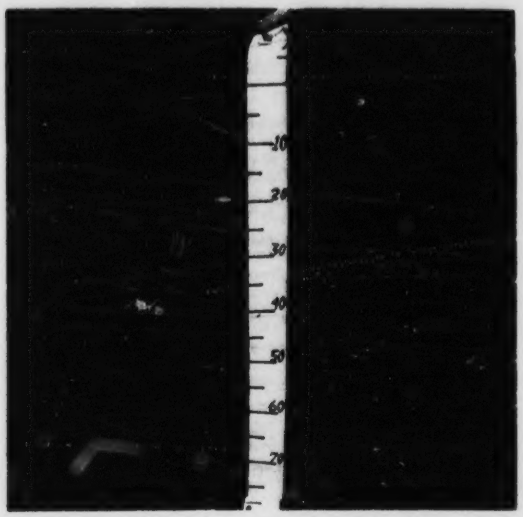
Soil profile of Cedar Lake clay till. A Orthic Gray Luv sol developed on moderately to strongly calcareous cla till.



Soil profile of a Nels loam. A Gleyed Cumulic Regosol developed on moderately calcareous coarse loamy recent alluvium.



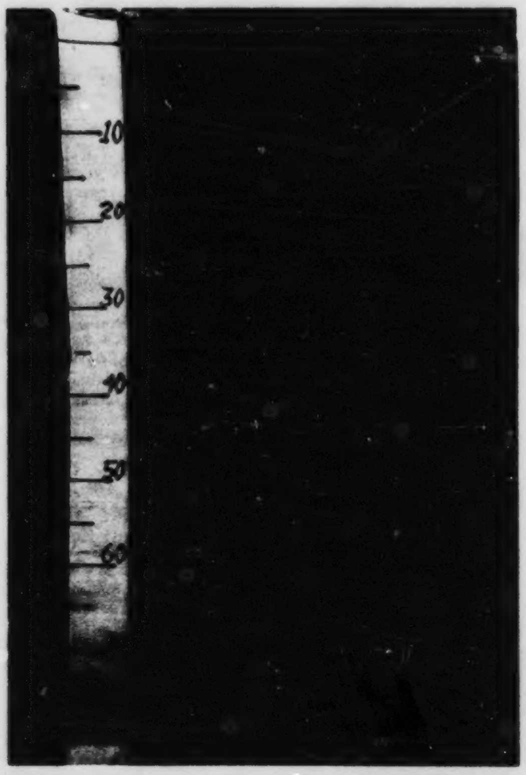
Soil profile of a Big Lake peaty phase. A Rego Gleyso carbonated, peaty, phase developed on moderately ca careous fine loamy recent alluvium.



Soil profile of Dering loam. A Rego Gleysol, carbonated phase developed on extremely calcareous till.

Soil profile of the Limestone Point shallow phase. A Eluviated Eutric Brunisol, extremely shallow lithic phase developed on 10-20 cm of extremely calcareous till over bedrock.

Soil profile of Kinwow clay. An Orthic Gray Luvisol developed on moderately to strongly calcareous clay over extremely calcareous till.



Soil profile of Tremauden gravel. A Gleyed Eluviated Eutric Brunisol developed on calcareous stratified sand and gravel.

FIGURE 10
Characteristic Soil Profiles in The Pas Map Area.

recently been defined as the pedon. This varies, but may often be one square metre in areal extent. The pedon is, however, too small to be represented on a map and the Soil Series Mapping Unit can therefore, be regarded as being composed of several contiguous pedons or polypedons whose properties may be individually different but all may be within the range defined for a given Soil Series.

A summary of the classification of soils in The Pas area is presented in Table 7. The relationship of these soils to their parent materials is indicated in Table 8.

TABLE 7
Classification of Soils in The Pas Map Area According to the System of Soil Classification for Canada (1978 revised)

Order	Great Group	Subgroup	Family	Series
Brunisolic Soils Well to imperfectly drained soils developed under mixed forest vegetation with brownish colored Bm horizon. It includes soils of various colors with both Ae horizons and weakly expressed B horizons of accumulations of either clay or amorphous compounds. Soils having a Bt horizon less than 5 cm thick are part of this order.	**Eutric Brunisols** Soils with organic surface horizons (L-H), with a brownish Bm horizon, a weakly acid to mildly alkaline solum, but without a distinct mineral-organic (Ah) surface horizon, pH is greater than 5.5 in the solum.	Orthic Eutric Brunisol Profile type: LFH, Bm, C or Ck	Fragmental to sandy skeletal, mixed strongly calcareous, moderately cold, to cold subhumid	Kawinaw
			Fragmental to sandy skeletal over loamy skeletal, mixed, strongly calcareous, to cold moderately cold, subhumid	Pim Lake
		Eluviated Eutric Brunisol Profile type: LFH, Ae or Aej, Bm or Btj, C or Ck	Loamy-skeletal, carbonatic, moderately cold to cold, subhumid	Atikameg Fairford
			Fragmental to sandy skeletal, mixed strongly calcareous, moderately cold to cold, subhumid	Freshford
			Loamy skeletal over rock, carbonatic, moderately cold to cold, subhumid	Limestone Point
			Fragmental to sandy skeletal over loamy skeletal, strongly calcareous, moderately cold to cold, subhumid	Soul Lake
		Gleyed Eluviated Eutric Brunisol Profile type: LFH, Ae or Aej, Bmgj or Btjgj, Cgj or Cg	Loamy-skeletal over rock, carbonatic, moderately cold to cold, humid	Birch Bay
			Loamy skeletal carbonatic, moderately cold to cold, humid	Chitek
			Fragmental to sandy skeletal over loamy skeletal, mixed, strongly calcareous, moderately cold to cold, humid	Horseshoe Island
			Fragmental to sandy skeletal, strongly calcareous, moderately cold to cold, humid	Tremauden
Chernozemic Soils Soils with chernozemic Ah horizons more than 10 cm thick and with B or C horizons of high base saturation divalent cations, calcium usually being dominant. Well to imperfectly drained soils developed under xero or mesophytic grasses and forbs under grassland forest transition.	**Black Soils** Soils with Ah or Ap horizon with dry color Munsell values darker than 3.5. Usually associated with mesophytic vegetation of grasses and forbs	Gleyed Rego Black Profile type: Ah, Ckgj	Loamy, mixed, strongly calcareous moderately cold to cold, humid	Swanford
	Dark Gray Soils These soils have a leaf mat (L-H) overlying gray to dark gray (Munsell value 3.5 to 5.5 dry, chroma less than 1.5), A horizons. The B horizon is moderately developed, dark brown, coarse granular to blocky and contains concentrations of clay.	Orthic Dark Gray Profile type: Ahe, Ae, Bm or Btj or Bt, Cca or CK	Clayey, montmorillonitic, moderately to strongly calcareous, moderately cold to cold, subhumid	Homebrook
		Gleyed Dark Gray Profile type: Ahe, Bmgj, Ckgj	Clayey, montmorillonitic, moderately to strongly calcareous, moderately cold to cold, subhumid	Davis Point
			Loamy, mixed, extremely calcareous, moderately cold to cold, humid	Duck River
			Loamy-skeletal, carbonatic, moderately cold to cold, humid	Inwood

TABLE 7 (Continued)

Order	Great Group	Subgroup	Family	Series
Cryosolic Soils Soils formed in either mineral or organic materials that have permafrost either within 1 m of the surface, or within 2 m, if more than ⅓ of the pedon has been strongly cryoturbated, as indicated by disrupted, mixed or broken horizons. They have a mean annual temperature below zero centigrade.	Organic Cryosols Soils having a surface organic layer (more than 17% organic carbon, about 30% organic matter by weight) either more than 40 cm thick, or more than 10 cm thick over a lithic contact, or more than 10 cm thick over an ice layer that is at least 30 cm thick. Perma-frost occurs within 1 m of the surface	Mesic Organic Cryosols Profile type: Of or Om, Om, Omz	Mesic, euic, cold, aquic	Nekik Lake
Gleysolic Soils Poorly drained soils which may have an organic horizon, an Ah horizon, or both, or neither of these horizons. The sub-soils show gleying and are dull colored, but may have brighter colored prominent mottles. Soils associated with wetness. They have developed under various climatic and vegetative conditions and in the presence of a high fluctuating watertable.	Humic Gleysol Soils Soils with an Ah horizon more than 10 cm thick under virgin conditions. When cultivated to a depth of 15 cm, they have an Ap layer with more than 2 percent organic carbon. They lack Bt horizons.	Rego Humic Gleysol Profile type: LFH or 0, Ah, Cg	Loamy, carbonatic, cold to moderately cold, aquic	Foley
			Clayey, montmorillonitic, moderately to strongly calcareous, cold to moderately cold, aquic	Koostatak
			Loamy skeletal, carbonatic, cold to moderately cold, aquic	Meleb
			Clayey over loamy skeletal, strongly calcareous, cold to moderately cold, aquic	Napanee Bay
			Clayey, montmorillonitic, strongly calcareous, cold to moderately cold, aquic	Sagemace
	Gleysol Soils Soils with no Ah horizon or Ah horizon less than 10 cm thick under virgin conditions and, when cultivated to a depth of 15 cm, they have an Ap layer with less than 2 present organic carbon. They lack Bt horizons.	Rego Gleysol Profile type: LFH or 0, Cg	Clayey, montmorillonitic, moderately to strongly calcareous, cold to moderately cold, aquic	Askandigau
			Clayey over sandy, mixed, moderately calcareous, cold to moderately cold, aquic	Big Eddy
			Fine loamy, moderately calcareous, cold to moderately cold, aquic	Big Lake
			Loamy skeletal, carbonatic, cold to moderately cold, aquic	Dering
			Fragmental to sandy skeletal over loamy skeletal, strongly calcareous, cold to moderately cold, aquic	Easterville
			Clayey, montmorillonitic, moderately calcareous, cold to moderately cold, aquic	Le Pas
			Loamy, mixed, strongly calcareous, cold to moderately cold, aquic	Marsh
			Fragmental to sandy skeletal, mixed, strongly calcareous, cold to moderately cold, aquic	Norris
			Loamy, strongly calcareous, cold to moderately calcareous, aquic	Novra
			Coarse loamy, mixed, moderately calcareous, cold to moderately cold, aquic	Pasquia
			Loamy skeletal, strongly saline, carbonatic, cold to moderately cold, aquic	Saline Flats

TABLE 7 (Continued)

Order	Great Group	Subgroup	Family	Series
Luvisolic Soils Well and imperfectly drained soils developed under forest or heath having light colored eluviated horizons and illuvial horizons with accumulations of dominantly translocated clay that are at least 5 cm thick.	**Gray Luvisol Soils** Soils with thin organic layers (L-H), with light colored eluviated horizons and with illuviated horizons in which clay is the main accumulation product. The solum generally has a medium to high degree of base saturation. Mean annual soil temperature is less than 8°C.	**Orthic Gray Luvisol** Profile type: LFH, Ae, AB, Bt, C or Ck	Clayey, montmorillonitic, strongly calcareous, cold to moderately cold, subhumid	Cedar Lake
			Clayey over rock, montmorillonitic, strongly calcareous, cold to moderately cold subhumid	Egg Island
			Clayey over loamy skeletal, montmorillonitic, strongly calcareous, cold to moderately cold, subhumid	Kinwow
			Fragmental to sandy skeletal over loamy skeletal, strongly calcareous, cold to moderately cold, subhumid	Long Point
			Loamy-skeletal, carbonatic, cold to moderately cold, subhumid	Westray
			Fragmental to sandy skeletal, mixed, strongly calcareous, cold to moderately cold, subhumid	Woodridge
		Solonetzic Gray Luvisol Profile type: LFH, Ae, AB, Btnj, BC, C or Csk	Clayey, montmorillonitic, strongly calcareous, cold to moderately cold, subhumid	Lettonia
		Gleyed Gray Luvisol Profile type: LFH, Ae, Btgj, Cg	Fragmental to sandy skeletal over loamy skeletal, strongly calcareous, cold to moderately cold, humid	Arbakka
			Clayey over loamy skeletal, montmorillonitic, strongly calcareous, cold to moderately cold, humid	Mantagao
			Fragmental to sandy skeletal, strongly calcareous, cold to moderately cold, humid	Sirko
			Clayey, montmorillonitic, strongly calcareous, cold to moderately cold, humid	Warpath
		Gleyed Solonetzic Gray Luvisol Profile type: LFH, Ae, ABgj, Btnjgj, Cgj, or Csag	Clayey, montmorillonitic, strongly calcareous, cold to moderately cold, humid	Mukatawa
Organic Soils Soils that have developed dominantly from organic deposits that are saturated for most of the year and contain 30% or more of organic matter to: a) a depth of at least 60 cm if the surface layer consists dominantly of fibric moss: or b) a depth of at least 40 cm for other kinds or mixed kinds of organic material; or c) a lithic contact if it occurs at depths greater than 10 cm.	**Fibrisol** Organic soils with a dominantly fibric middle tier, or middle and surface tiers if a terric or lithic contact occurs in the middle tier.	**Typic Fibrisol** These soils consist of uniform fibric organic matter derived from Sphagnum mosses throughout the middle and bottom tiers. They lack subdominant mesic and humic layers. They lack terric, lithic, hydric or other layers in the control section. Common horizon sequence: Of or Om, Of	Sphagnic, dysic, cold, aquic	Julius
		Mesic Fibrisol These soils consist of a dominantly fibric middle tier and a subdominant mesic layer thicker than 25 cm in the middle or bottom tier. Other layers are absent. Common horizon sequence: Of or Om, Of, Om	Sphagnic, dysic, cold, aquic	Whithorn

TABLE 7 (Continued)

Order	Great Group	Subgroup	Family	Series
		Terric Fibrisol These soils have a terric layer (mineral soil) beneath the surface tier Cumulo or limno layers may be present, but other kinds are absent. Common horizon sequence: Of or Om, Of, Cg	Sphagnic, euic, cold, aquic, loamy-skeletal	Elmore
			Sphagnic, euic, cold, aquic, sandy	Monkman
			Sphagnic, euic, cold, aquic, clayey	Sadlow
		Terric Mesic Fibrisol These soils have a terric layer (mineral soil) beneath the surface tier and a significant subdominant mesic layer thicker than 25 cm in the organic portion of the control section. Common horizon sequence: Of or Om, Of, Om, C	Sphagnic, euic, cold, aquic, sandy	Catfish Point Sand River
			Sphagnic, euic, cold, aquic, loamy skeletal	Kilkenny
			Sphagnic, euic, cold, aquic, clayey	Chocolate Molson
	Mesisol These organic soils have a dominantly mesic middle tier, or middle and surface tiers if a terric, or lithic, contact occurs in the middle tier.	**Typic Mesisol** These soils consist of dominantly mesic material throughout the middle and bottom tiers. The control section lacks any terric, hydric, cumulo or limno layers. Common horizon sequence: Of, Om, or Oh, Om.	Mesic, euic, cold, aquic	Baynham Rock Island Stead
			Sphagnic, euic, cold, aquic	Katimik Waskwei
		Fibric Mesisol These soils consist of a dominantly mesic middle tier and a subdominant fibric layer thicker than 25 cm in the middle or bottom tier. Other layers are absent. Common horizon sequence: Of, Om, or Oh, Om, Of, Om	Sphagnic, euic, cold, aquic	Santon
		Terric Mesisol These soils have a terric layer beneath the surface tier. Cumulo or limno layers may be present but other layers are absent. Common horizon sequence: Of, Om, or Oh, Om, C, Om	Mesic, euic, cold, aquic, clayey	Cayer Okno Reed Lake
			Sphagnic, euic, cold, aquic, clayey	Howell Orok
			Mesic euic, cold, aquic, loamy-skeletal	Crane Grindstone
			Sphagnic, euic, cold, aquic, loamy-skeletal	Halcrow Lamb Lake
			Mesic, euic, cold, aquic, sandy	Kircro Rat River
		Terric Fibric Mesisol These soils have a terric layer beneath the surface tier and subdominant fibric layer thicker than 25 cm in the organic portion of the control section. Cumulo layers may be present but other kinds are not. Common horizon sequence: Of, Om, or Oh, Om, Of, C, Om.	Sphagnic, euic, cold, aquic, sandy	Guy Hill
			Sphagnic, euic, cold, aquic, clayey	Sisib
			Sphagnic, euic, cold, aquic, loamy-skeletal	Ferland
			Sphagnic, euic, cold, aquic, sandy	Turnberry

TABLE 7 (Continued)

Order	Great Group	Subgroup	Family	Series
		Hydric Mesisol These soils have a hydric layer of water that extends from a depth of not less than 40 cm to a depth more than 160 cm. They may also have humic, cumulic, terric or limnic layers. Common horizon sequence: Of, Om, or Oh, Om, W	Mesic, euic, cold, aquic	Overflowing
Regosolic Soils Well and imperfectly drained soils with good to moderate oxidizing conditions having horizon development too weak to meet the requirements of soils in any other order	Regosol Soils Well and imperfectly drained soils with good to moderate oxidizing conditions and weak horizon development	Orthic Regosol Profile type: C	Sandy, calcareous, cold to moderately cold, subhumid to humid	Sand Beaches
		Gleyed Cumulic Regosol Profile type: Cgj, Ahb, Cgj	Fine loamy, moderately calcareous cold to moderately cold, humid	Carrot
			Loamy, moderately to strongly calcareous, cold to moderately cold, humid	Homestead
			Coarse loamy, moderately calcareous, cold to moderately cold, humid	Nels

RELATION BETWEEN SOIL TAXONOMY AND SOIL MAPPING

Soil Taxonomy

Soil taxonomy provides a means of differentiating and describing soils and map units. There are, however, differences between taxonomic units, sampling units and mapping units. Each may be termed a Soil Series. The taxonomic unit really is the soil profile, it is two dimensional in that the profile can be represented as a vertical slice through all the soil layers at one point on the landscape. The pedon is the sampling unit which really is the test pit used to define the in situ characteristics of that profile, to obtain samples for laboratory testing and to adequately express these characteristics as an average for a specified volume at one point on the landscape. The third unit, the mapping unit, is also three dimensional but instead of representing one point on the landscape, it actually represents a landscape segment. Soil mapping requires the delineation of segments of the soil landscape that are relevant to the objective of the survey. These segments may be taxonomically pure, but very often at the scale of mapping used in the The Pas area they consist of a complex grouping of two or more soils. In such case, their complexity is described rather than subdivided into smaller units to achieve uniformity. But it is also implied, to a greater or lesser extent, that everywhere in a delineated landscape segment the actual sequence of soil layers is the same as those exhibited in the test pit and those described and classified in the soil profile. The whole purpose of this is to predict the behaviour or performance of these same landscape units when subjected to given sets of management systems.

Mapping Units

A map unit represents real and mappable portions of the soil landscape that together have attributes varying within more or less narrow limits determined by the intensity of the survey and its objectives. Generally, mappable differences in any property or group of properties that have significance in soil formation or plant growth are the basis for delineating map units. Differences in soil parent material, drainage, topographic variations, salinity and textural variation have been the key characteristics employed for differentiation.

A map unit contains predominantly one or more than one soil plus a certain proportion of undescribed inclusions. If the inclusions make up only a small proportion of the map unit it is regarded as a single map unit. Such map units are relatively pure with respect to the soil used to identify it eg. a map unit identified by, In or Inwood series includes a predominance of soils having properties as defined for the Inwood series. Map units identified by the Inwood series may contain small segments (usually less than 15 percent) of other soils. If two or more soils each make up a significant proportion of the whole map unit, then they contribute to the definition of a compound map unit. Compound map units are used to describe landscapes where different soils are so intricately mixed or small in size, that it is not practical to show them separately on the map. A map unit identified as Fd4 Ci3 Dr3 consists of 40 percent Fairford soils, 30 percent Chitek soils and 30 percent Dering soils.

FIELD PROCEDURES

Field work in The Pas area was carried out on a reconnaissance to exploratory scale. Traverses were made along all existing roads digging every quarter mile. The Saskeram and Summerberry areas were covered using a bombadier track vehicle on traverses, and foot traverses. The remaining more inaccessible areas were covered by limited helicopter traverses. The soils were examined at frequent intervals on the traverses, the frequency being determined by the soil variability in the area. The boundaries of the soil areas and relevant physical features were projected from the areas of ground inspection by interpretation of aerial photographs. The information obtained from the soil inspections and associated landscapes were plotted on one inch to one mile scale aerial photos, and then transfered to a manuscript base at a scale of one inch equal two miles for publication.

A number of representative soil profiles were described in detail and sampled for laboratory analyses to characterize the chemical, physical and morphological properties of the soils.

The delineation of map units whether they be identified by single soil series or soil series complexes, is not exact. It varies with local topography, drainage, erosion, and soil profile properties. The decision to outline and label any given area is based on interpretation and extrapolation of observed soil and landscape features and air photo interpretation. The delineation of soil boundaries serves to separate soils having properties and conditions which are significant for potential use as field management units. The soil map legend lists all soil series alphabetically and provides limited definitions of soil characteristics and landscape properties such as drainage, surface texture, topography, stoniness and the presence of soluble salts. More specific definition of the various topography, stoniness and salinity classes are given in the Glossary, Appendix A.

DESCRIPTION OF SOIL SERIES AND MAPPING UNITS

The soils of The Pas Area are grouped according to parent material and drainage in Table 8. The classification of each soil series at the subgroup level is indicated in the table as is the total hectareage occupied by each series. These include areas mapped as the individual series and the area covered by each series within various complex mapping units. Phases of soil series, indicative of peaty overlays, salinity or topographic classes have separate area figures. The percentage of the total map area covered by each soil series and phase is also given.

The soil series descriptions include a general description of the profile type, texture and parent material, location within the map area, topography and drainage, and the occurrence of the series in complex association with other soils. A detailed tabular morphological description of a representative profile of the series is given, together with analytical data for that series. Further information on the suitability and management of each soil for agriculture, their engineering properties and recreational development is given in Part 4 of the report.

Askandigau Series (As)

The Askandigau series are poorly drained Rego Gleysol soils developed on moderately to strongly calcareous, clayey glacial till. Topography of Askandigau areas is depressional to nearly level. Usually a very thin 0 to 15 cm layer of mesic peat covers the surface of these soils. The clay texture of the surface contributes to very slow internal percolation of water. Also, because of their topographic position, the surface runoff is practically nil. Generally the surface is relatively stone free. The native vegetation of the Askandigau series is dominantly black spruce with some willows. The ground cover is mainly composed of mixed mosses with sedges and reed grasses in some areas. A representative profile of an Askandigau, soil is described below:

Om -	15 to 0 cm, moderately decomposed woody and herbaceous materials; medium acid; abrupt, smooth boundary.
IIAhg -	0 to 7.5 cm, gray (10YR 4/1, moist), silty clay; strong, medium subangular blocky; slightly acid; gradual, wavy boundary.
IICg -	7.5 to 28 cm, gray to grayish brown (10YR 5/1 to 5/2, dry), dark gray (5Y 4/1, moist), clay; strong, coarse granular; neutral; gradual, irregular boundary.
IICkg1 -	28 to 48 cm, light brownish gray to gray (10YR 6/2 to 6/1, dry), gray (5Y 5/1, moist), clay; moderate, coarse granular; mildly alkaline; moderately calcareous; gradual, irregular boundary.
IICkg2 -	48 to 68 cm, light gray to gray (10YR 6/1, dry), gray to grayish brown (10YR 5/1 to 5/1, moist), clay; amorphous; mildly alkaline; moderately calcareous.

The Askandigau soils usually have a layer of moderately decomposed peat on the surface, and a thin grayish Ahg or AC horizon overlying a gleyed Cg horizon. Numerous isolated pockets of extremely calcareous, loamy till occur within the clayey matrix of the parent material.

The Askandigau, peaty phase soils of the Low Boreal climatic zone correlate with the Sagemace, peaty phase soils of the High Boreal-temperate climatic zone, located in the south-western portion of the map sheet.

The Askandigau and Askandigau peaty phase soils are commonly associated with the Warpath and Davis Point series, and also with the Molson and Orok organic soil complexes.

TABLE 8
Parent Materials, Soils, and their Estimated Extent in The Pas Map Area

	Area (ha)	Percent of Map Area
A. Soils developed on glacial till		
1. Extremely calcareous loamy till of predominantly limestone origin.		
a) Well and moderately well drained		
• Westray series (Orthic Gray Luvisol)	1 073	.08
• Atikameg series (Eluviated Eutric Brunisol)	17 925	1.40
• Fairford series (Eluviated Eutric Brunisol)	1 497	.12
b) Imperfectly drained		
• Chitek series (Gleyed Eluviated Eutric Brunisol)	48 425	3.79
• Inwood series (Gleyed Dark Gray)	281	.02
c) Poorly drained		
• Dering series (Rego Gleysol carbonated phase)	17 044	1.33
• Dering series, peaty phase	43 381	3.39
• Meleb series (Rego Humic Gleysol carbonated phase)	275	.02
• Meleb series, peaty phase	8 713	.68
2. Thin, less than one meter thick, extremely calcareous loamy till deposits overlying limestone bedrock.		
a) Well and moderately well drained		
• Limestone Point series (Eluviated Eutric Brunisol)	20 422	1.60
• Limestone Point series, shallow phase	14 286	1.12
b) Imperfectly drained		
• Birch Bay series (Gleyed Eluviated Eutric Brunisol)	1 792	.14
3. Moderately to strongly calcareous clayey glacial till.		
a) Well and moderately well drained		
• Cedar Lake series (Orthic Gray Luvisol)	16 971	1.33
• Homebrook series (Orthic Dark Gray)	2 863	.22
b) Imperfectly drained		
• Warpath series (Gleyed Gray Luvisol)	12 812	1.00
• Davis Point series (Gleyed Dark Gray)	6 380	.50
c) Poorly drained		
• Askandigau series (Rego Gleysol)	3 089	.24
• Askandigau series, peaty phase	8 627	.67
• Sagemace series (Rego Humic Gleysol peaty phase)	5 441	.43
B. Soils developed on lacustrine materials		
1. Thick, greater than one meter, moderately to strongly calcareous loamy lacustrine sediments.		
a) Imperfectly drained		
• Swanford series (Gleyed Rego Black)	521	.04
• Duck River series (Gleyed Dark Gray)	2 886	.23
b) Poorly drained		
• Foley series (Rego Humic Gleysol carbonated phase)	521	.04
• Foley series, peaty phase	768	.06
2. Thick, greater than one meter, moderately to strongly calcareous, clayey lacustrine sediments.		
a) Well drained		
• Lettonia series (Solonetzic Gray Luvisol)	158	.01
b) Imperfectly drained		
• Mukatawa series (Gleyed Solonetzic Gray Luvisol)	546	.04
c) Poorly drained		
• Koostatak series (Rego Humic Gleysol)	1 528	.12
• Koostatak series, peaty phase	3 088	.24
3. Thin, usually less than one meter thick, moderately to strongly calcareous clayey lacustrine sediments overlying extremely calcareous stony loamy till.		
a) Well drained		
• Kinwow series (Orthic Gray Luvisol)	1 395	.11
b) Imperfectly drained		
• Mantagao series (Gleyed Gray Luvisol)	4 893	.38
c) Poorly drained		
• Napanee Bay series (Rego Humic Gleysol peaty phase)	356	.03

TABLE 8 (Continued)

	Area (ha)	Percent of Map Area
4. Thin, usually less than one meter thick, moderately to strongly calcareous clayey lacustrine sediments underlain by stony, extremely calcareous loamy till, limestone bedrock usually occurs within one meter of the surface.		
a) Well drained		
• Egg Island series (Orthic Gray Luvisol)	994	.08
C. Soils developed on stratified sand and gravel outwash and beach deposits		
1. Thick, greater than one meter thick, stratified strongly to very strongly calcareous, sandy skeletal to fragmental outwash and beach deposits.		
a) Well drained		
• Freshford complex (Eluviated Eutric Brunisol* Orthic Gray Luvisol, Orthic Eutric Brunisol)	4 498	.35
b) Imperfectly drained		
• Tremauden complex (Gleyed Eluviated Eutric Brunisol, Gleyed Gray Luvisol)	2 694	.21
c) Poorly drained		
• Norris series (Rego Gleysol carbonated phase)	3 161	.25
• Norris series, peaty phase	7 622	.60
2. Thin, less than one meter, strongly to very strongly calcareous sandy skeletal to fragmental deposits overlying stony extremely calcareous loamy textured till.		
a) Well drained		
• Soul Lake complex (Eluviated Eutric Brunisol*, Orthic Gray Luvisol, Orthic Eutric Brunisol)	1 936	.15
b) Imperfectly drained		
• Horseshoe Island complex (Gleyed Eluviated Eutric* Brunisol, Gleyed Gray Luvisol)	3 544	.27
c) Poorly drained		
• Easterville series (Rego Gleysol carbonated peaty phase)	1 296	.10
D. Soils developed on recent alluvial deposits		
1. Weakly to moderately calcareous coarse loamy stratified recent alluvial deposits. Layers range from sand to clay in texture.		
a) Imperfectly drained		
• Nels series (Gleyed Cumulic Regosol)	19 364	1.51
b) Poorly drained		
• Pasquia series (Rego Gleysol carbonated phase)	6 075	.48
• Pasquia series, drained phase	1 052	.08
• Pasquia series, peaty phase	7 839	.61
2. Weakly to moderately calcareous fine loamy stratified recent alluvial deposits. Layers range from sand to clay in texture.		
a) Imperfectly drained		
• Carrot series (Gleyed Cumulic Regosol)	10 810	.85
• Homestead series (Gleyed Cumulic Regosol)	1 103	.09
b) Poorly drained		
• Big Lake series (Rego Gleysol carbonated phase)	16 297	1.27
• Big Lake series, drained phase	410	.03
• Big Lake series, peaty phase	22 637	1.77
• Novra series (Rego Gleysol)	1 276	.10
• Novra series, peaty phase	1 874	.15
3. Weakly to moderately calcareous, clayey stratified recent alluvial deposits, with thin layers of peat, sand and clay.		
a) Poorly drained		
• Le Pas series (Rego Gleysol carbonated phase)	8 909	.70
4. Weakly to moderately calcareous dominantly clayey stratified recent alluvial deposits underlain by sandy deposits, the alluvium ranges from sand to clay in texture.		
a) Poorly drained		
• Big Eddy series (Rego Gleysol carbonated, drained phase)	571	.04

TABLE 8 (Continued)

	Area (ha)	Percent of Map Area
E. Soils developed on poorly to very poorly drained organic deposits		
1. Dominantly moderately decomposed fen peat.		
a) 40 to 160 cm of mesic fen peat with little or no (<15 cm) Sphagnum surface peat deposits overlying (i) loamy to clayey lacustrine deposits (ii) sandy deposits (iii) extremely calcareous loamy till.		
• (i) Reed Lake complex (Terric Mesisol*, Terric Mesisol sphagnic phase)	669	.05
• (i) Cayer series (Terric Mesisol)	107 768	8.43
• (ii) Kircro series (Terric Mesisol)	15 515	1.21
• (iii) Crane series (Terric Mesisol)	15 246	1.19
b) 40 to 160 of mesic fen peat with a very thin (15 to 65 cm) of fibric Sphagnum peat surface layer overlying (i) loamy to clayey lacustrine deposits (ii) extremely calcareous loamy textured till.		
• (i) Howell series (Terric Mesisol, sphagnic phase)	9 756	.76
• (ii) Halcrow series (Terric Mesisol, sphagnic phase)	5 907	.46
c) Deep (>160 cm) mesic fen peat with little or no (<15 cm) fibric Sphagnum peat surface. All these soils underlain by undifferentiated materials.		
• (i) Rock Island complex (Typic Mesisol*, Typic Mesisol sphagnic phase)	1 115	.09
• (i) Stead series (Typic Mesisol)	34 628	2.71
d) Deep (>160 cm) mesic fen peat with a hydric layer occuring between 40-130 cm and underlain by (i) undifferentiated materials.		
• (i) Overflowing series (Typic Mesisol aquic phase)	11 597	.91
e) Deep (>160 cm) mesic fen peat with a very thin (15 to 65 cm) fibric Sphagnum peat surface layer underlain by (i) undifferentiated materials.		
• (i) Katimik series (Typic Mesisol sphagnic phase)	16 475	1.29
2. Dominantly moderately well decomposed forest peat		
a) 40 to 160 cm of mesic forest peat with (<65 cm) of fibric Sphagnum surface peat deposits, which overlie (i) loamy to clayey lacustrine deposits (ii) sandy deposits (iii) extremely calcareous till.		
• (i) Okno complex (Terric Mesisol* Terric Mesisol sphagnic phase, Terric Fibric Mesisol)	10 001	.78
• (ii) Rat River complex (Terric Mesisol* Terric Mesisol sphagnic phase, Terric Fibric Mesisol)	8 096	.63
• (iii) Grindstone complex (Terric Mesisol* Terric Mesisol sphagnic phase, Terric Fibric Mesisol)	8 277	.65
b) 40 to 160 cm of mesic forest peat with a very thin (15 to 65 cm) Sphagnum surface peat deposits overlying (i) loamy to clayey lacustrine deposits (ii) sandy to gravelly deposits (iii) extremely calcareous till.		
• (i) Orok complex (Terric Mesisol sphagnic phase*, Terric Mesic Fibrisol, Terric Fibric Mesisol, Terric Mesisol)	12 059	.94
• (ii) Guy Hill complex (Terric Mesisol sphagnic phase*, Terric Mesic Fibrisol, Terric Fibric Mesisol, Terric Mesisol)	3 476	.27
• (iii) Lamb Lake complex (Terric Mesisol sphagnic phase*, Terric Mesic Fibrisol, Terric Fibric Mesisol, Terric Mesisol)	35 422	2.77
c) Deep (>160 cm) mesic forest peat with a very thin (15 to 65 cm) Sphagnum surface peat deposits overlying (i) undifferentiated materials.		
• (i) Waskwei complex (Typic Mesisol sphagnic phase*, Typic Mesisol)	6 565	.51
3. Dominantly undecomposed Sphagnum peat		
a) 40 to 160 cm of Sphagnum peat overlying mesic forest or fen peat, with a thin to very thick (65-160 cm) continuous fibric Sphagnum peat surface, underlain by (i) loamy to clayey lacustrine sediments (ii) sandy to gravelly deposits (iii) extremely calcareous till.		
• (i) Molson complex (Terric Mesic Fibrisol*, Terric Fibric Mesisol, Terric Fibrisol)	51 560	4.03

TABLE 8 (Continued)

	Area (ha)	Percent of Map Area
• (i) Chocolate complex (Terric Mesic Fibrisol*, Terric Fibric Mesisol, Terric Fibrisol)	1 015	.08
• (ii) Sand River complex (Terric Mesic Fibrisol*, Terric Fibric Mesisol, Terric Fibrisol)	11 387	.89
• (ii) Catfish Point series (Terric Mesic Fibrisol*, Terric Fibric Mesisol, Terric Fibrisol)	1 210	.09
• (iii) Kilkenny complex (Terric Mesic Fibrisol*, Terric Fibric Mesisol, Terric Mesisol)	10 686	.84
b) Organic deposits (>160 cm) with a surface layer of fibric Sphagnum peat >65 cm overlying mesic forest or fen peat underlain by (i) undifferentiated material.		
• (i) Whithorn complex (Mesic Fibrisol*, Typic Fibrisol, Fibric Mesisol)	18 470	1.44
F. Soils developed on deep perennially frozen forest peat or thin Sphagnum peat overlying frozen mesic forest peat, underlain by undifferentiated materials.		
• (i) Nekik Lake complex (Mesic Organic Cryosol*, Fibric Organic Cryosol)	913	.07
* Dominant member of complex		
G. Miscellaneous Land Types		
1. Sandy and stony beaches and bars (Orthic Regosol)	265	.02
2. Saline Flats (Saline Rego Gleysol)	350	.03
3. Marsh complex (Rego Gleysol carbonate phase, Rego Gleysol)	15 931	1.25
4. Limestone and Dolostone rock outcrop	5 430	.42
5. Water (lakes and rivers)	430 480	33.72
6. The Pasquia Land Settlement, Report No. 11.	56 288	4.40
Total Hectares	1 278 476	100%

Mapping Units

Askandigau Series (As)

These areas consist dominantly of normal Askandigau series with small amounts of Askandigau, peaty phase soils. Area mapped is 3 089 hectares or 0.24 percent of the map area.

Askandigau peaty phase (As(P))

These areas consist dominantly of Askandigau soils having 15 to 40 cm of mesic peat materials on the surface. Area mapped is 8 627 hectares or 0.67 percent of the map area.

Atikameg Series (At)

The Atikameg series consists of moderately well and well drained Eluviated Eutric Brunisol soils developed on extremely calcareous, loamy till. Dominant surface textures vary from loam to clay loam. Topography is gently undulating to undulating. The Atikameg soils usually occur in the well drained positions in drumlinized or ridge and swale ground moraine. Runoff and permeability are generally moderate. In areas with little or no lacustrine overlay and where severe water

TABLE 9.
Analysis of Askandigau Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil				
															Ca	Mg	K	Na	H
Om	15-0	—	—	—	—	5.9	—	—	—	—	39.0	1.54	25	163.0	65.2	49.4	1.8	0.5	15.4
IIAhg	00-7.5	SiC	14	40	46	6.3	0.4	—	—	—	2.2	0.16	14	30.3	12.2	16.4	0.9	0.5	1.8
IICg	7.5-28	C	19	27	54	6.9	0.4	tr	—	—	—	—	—	29.8	12.0	17.5	0.9	1.0	0.6
IICkg1	28-48	C	03	29	68	7.7	0.6	9.7	2.1	7.1	—	—	—	31.6	—	—	—	—	—
IICkg2	48-68+	C	02	36	62	7.8	0.1	15.3	4.5	10.8	—	—	—	27.2	—	—	—	—	—

working has been experienced, these soils are exceedingly stony. The surface may be only moderately stony, however, in areas of less waterworking. Spruce, jack pine and aspen constitute the major native tree cover on Atikameg soils. A representative profile of the Atikameg series is outlined below.

L-H -	5 to 0 cm, leaf and grass mat; slightly acid; abrupt, smooth boundary.
Aej -	0 to 2 cm, pale brown (10YR 6/3, dry), brown (10YR 5/3, moist), clay loam; fine granular; friable when moist, soft when dry; neutral; abrupt, smooth boundary.
Btj -	2 to 6 cm, light yellowish brown to brown (10YR 6/4 to 5/3, dry), dark brown to brown (10YR 4/3, moist), loam; weak, fine subangular blocky breaking to weak, fine granular; friable when moist, slightly hard when dry; neutral; moderately calcareous; abrupt, smooth boundary.
BCk -	6 to 12 cm, gray to light brownish gray (10YR 5/1 to 6/2, dry) brown to pale brown (10YR 5/3 to 6/3, moist), gravelly silt loam; single grained; loose when moist; loose when dry; mildly alkaline; extremely calcareous; abrupt, smooth boundary.
Ck1 -	12 to 18 cm, light gray (10YR 7/2, dry), light brownish gray (10YR 6/2, moist), silt loam; weak, fine, pseudo platy; friable when moist, hard when dry; mildly alkaline, extremely calcareous; clear, smooth boundary.
Ck2 -	18 to 38 cm, white (10YR 8/2, dry), very pale brown (10YR7/2, moist) silt loam, weak, fine pseudo platy; friable when moist, hard when dry; mildly alkaline; extremely calcareous; clear, smooth boundary.
Ck3 -	38 to 58 cm, white (10YR 7.5/2, moist), silt loam; weak, pseudo platy; friable when moist, hard when dry; mildly alkaline; extremely calcareous.

The solum of the Atikameg soils is generally less than 20 cm thick, characterized by a thin light colored, often discontinuous Ae or Aej horizon overlying a thin, weakly developed textural Btj horizon. Minor areas of the Westray series, an Orthic Gray Luvisol with more pronounced profile development, may occur in areas of Atikameg series. The Westray soils cannot be mapped separately due to the limited ground truth and the reconnaissance scale of the survey. These soils occur most frequently in areas with bedrock near the surface, where soil drainage is better and more rapid downward movement of water occurs.

The Atikameg soils often occur in complex association with soils of the Chitek, Limestone Point, and Cedar Lake series. The Atikameg series, mapped in the Low Boreal climatic zone, correlates with the Fairford series of the High Boreal-temperate climatic zone.

Mapping Unit

The Atikameg soils are widely distributed throughout the map area, covering some 17 925 hectares (1.4 percent of the map area).

Big Eddy Series, drained phase Be(d)

This soil is equivalent to the better drained Le Pas sand substrate phase in the detailed soil survey of the "Pasquia Map Area", Report No. 11. These soils are Rego Gleysols, carbonated phase, developed on 20 to 60 cm of clay, abruptly terminated by a sand substrate. These soils are moderately calcareous and moderately alkaline throughout and generally are slightly saline. The topography is level. The vegetation is reeds and sedges. Some organic matter in the form of peat and/or muck is present on the surface and in bands within the soil section. Where mixing by cultivation has occured, the surface soils have a

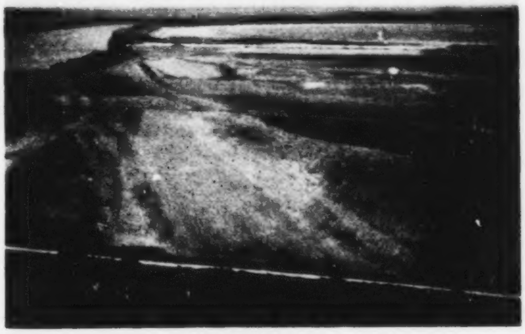


FIGURE 11

Aerial view of part of Rahls Island. Big Eddy drained phase, Nels, Le Pas and Pasquia drained phase soils are all present in the picture.

TABLE 10.
Analysis of Atikameg Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil				
															Ca	Mg	K	Na	H
L-H	5-0	—	—	—	—	6.1	0.6	—	—	—	44.0	0.60	73.3	98.9	61.8	24.9	0.7	0.3	12.1
Aej	0-2	CL	29	38	33	6.6	0.6	—	—	—	04.6	0.16	28.8	25.6	18.5	08.8	0.1	0.1	02.4
Btj	2-6	L	27	48	25	7.2	0.6	10.4	0	09.6	04.3	0.18	24.1	33.6	—	—	—	—	—
BCK	6-12	Gravelly SiL	21	68	11	7.5	0.6	58.2	20.2	35.0	03.9	0.28	13.9	22.5	—	—	—	—	—
Ck1	12-18	SiL	16	75	09	7.5	0.4	83.6	12.7	65.4	—	—	—	09.9	—	—	—	—	—
Ck2	18-38	SiL	12	77	11	7.6	0.3	90.9	25.5	60.2	—	—	—	03.0	—	—	—	—	—
Ck3	38-58	SiL	14	75	11	7.7	0.3	85.9	21.2	59.7	—	—	—	04.1	—	—	—	—	—

dark color much like the grassland soils in the southern part of Manitoba.

Mapping Unit

This soil is found only in the Saskatchewan River delta, and accounts for 571 hectares or 0.04 percent of the map area.

Big Lake Series (B)

The Big Lake series consists of poorly to very poorly drained Rego Gleysol, carbonated phase soils developed on recent alluvium. The texture of the solum varies from very fine sandy loam to silty clay loam with moderate amounts of lime carbonate. Bands of organic matter and layers of fine sand to clay textured sediments are common in these soils. All of the Big Lake soils are covered by a thin layer of peat. The topography is level, and the vegetation is dominantly reeds, sedges and willows. This soil is only found in the Saskatchewan River delta.

Om1 - 34-0 cm, dark reddish brown (5YR 3/2 moist) black (10YR 2/1 dry) moderately decomposed fen peat, medium to fine fibered, non-woody, slightly acid, abrupt smooth boundary.

IICkg1 - 0-15 cm, very dark grayish brown (10YR 3/2 moist) dark grayish brown (10YR 4/2) dry silty clay; few fine prominent dark reddish brown (5YR 3/3) mottles; weak fine pseudo-platy breaking to weak fine granular, moist friable, dry soft; mildly alkaline; moderately calcareous; abrupt smooth boundary.

IICkg2 - 15-54 cm, very dark grayish brown (10YR 3/2 moist) dark grayish brown (10YR 4/2 dry) silty clay with thin very fine sandy loam layers; few fine faint brown to dark brown (10YR 4/3) mottles; weak fine pseudo-platy breaking to weak fine granular; moist very friable; dry soft; mildly alkaline; moderately calcareous; clear smooth boundary.

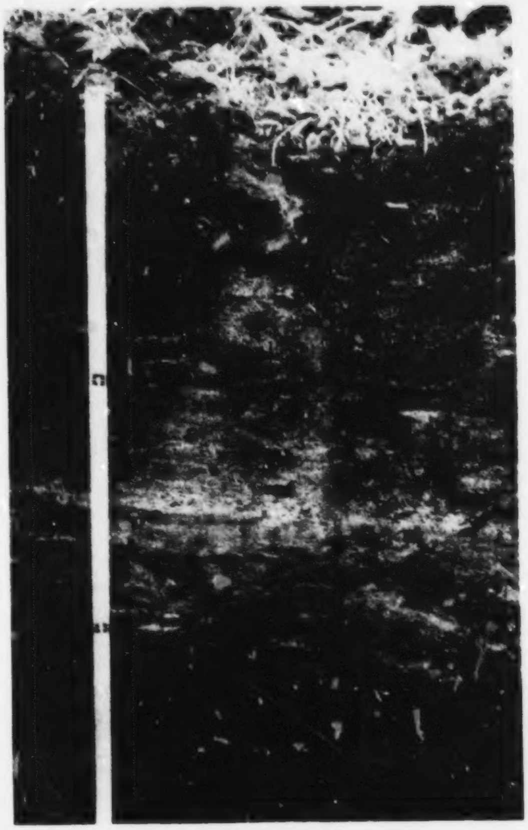


FIGURE 12
Soil Profile of Big Lake peaty phase. A Rego Gleysol carbonated peaty phase developed on moderately calcareous fine loamy alluvium.

TABLE 11.
Analysis of Big Lake Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	
Om	34-0	—	—	—	—	6.2	0.8	—	—	—	14.8	1.6	9.2	89.6	73.9	13.7	0.3	0.5	6.8	
IICkg1	0-15	SiC	5	49	46	7.3	0.9	5.4	3.4	2.0	—	—	—	44.3	—	—	—	—	—	
															Soluble Salts meq/1					
															Ca	Mg	Na	SO_4	Cl	HCO_3
IICkg2	15-54	SiC	7	52	41	7.3	1.8	6.5	3.9	2.5	—	—	—	31.1	16.1	5.4	1.1	15.5	1.0	4.0
IICkg3	54-88	SiCL	8	56	36	7.4	1.0	11.0	7.4	3.4	—	—	—	28.5	—	—	—	—	—	—

IICkg3 - 54-88 cm, dark gray (5YR 4/1 moist) brown (10YR 5/3 dry) silty clay loam; few fine faint dark reddish brown (5YR 3/4) mottles; moderate fine granular; moist friable, dry slightly hard; mildly alkaline, moderately calcareous.

Mapping Units

Big Lake Series (B)

These areas consist dominantly of normal Big Lake series. Area mapped is 16 297 hectares or 1.27 percent of the map area.

Big Lake peaty phase B(p)

These areas consist dominantly of Big Lake soils with 15 to 40 cm of mesic peat on the surface. Small amounts of Big Lake series may be found in this unit. Area mapped is 22 637 hectares or 1.77 percent of the map area.

Big Lake drained phase B(d)

These consist of better drained normal Big Lake series. Area mapped is 410 hectares or 0.03 percent of the map area.

Birch Bay Series (Bc)

These soils are imperfectly drained Gleyed Eluviated Eutric Brunisol soils developed on 20 to 100 cm of extremely calcareous loamy till over limestone bedrock. Due to the thin veneer of till they are developed on, these soils are considered shallow and very shallow lithic phases. Areas of Birch Bay soils have nearly level to gently sloping topography. Surface texture varies from fine sandy loam to clay loam. Birch Bay soils have slow to moderate surface runoff and slow internal percolation of water. These soils are very stony due to the nature of the till and the proximity of the limestone bedrock. Vegetative cover is dominantly spruce, aspen, jack pine and some willow.

The solum of Birch Bay soils is generally less than 20 cm thick, characterized by a thin, light colored, often discontinuous Ae or Aej horizon overlying a thin, weakly developed textural Btj horizon.

The Birch Bay soils are often associated in mapping units with soils of the Limestone Point shallow phase, Biscuit Point, and Chitek series. The Birch Bay soils of the Low Boreal climate zone correlate with the Faulkner series in the High Boreal-temperate climatic zone, and with the Inwood series, rock substrate phase, as mapped in the Grahamdale Area (Soils Report No. 16).

Mapping Unit

The area represented by the Birch Bay series is 1 792 hectares, which is 0.14 percent of the map area.

Carbonate Bedrock (cR)

Areas with less than ten centimeters of unconsolidated mineral material over bedrock were mapped as Carbonate Bedrock. The rocks are flat-bedded dolostones and limestones of Paleozoic age. These sites are normally very arid because the rocks are pitted and fractured. Topography varies from nearly level to gently sloping in these areas. Native vegetation on Carbonate Bedrock areas consists of stunted aspen and jack pine with a sparse growth of lichens, grasses and herbs.

FIGURE 13

Limestone Bedrock with less than 10cm of unconsolidated material at the surface.

Surface outcroppings are mainly Silurian dolomites. Which occur along the east side of the sheet. These often occur in association with the Limestone Point and Limestone Point shallow phase series.

Mapping Unit

Carbonate Bedrock occupies a total of 5 430 hectares, or 0.42 percent of the map area.

Carrot Series (C)

The Carrot series consists of imperfectly drained Gleyed Cumulic Regosols soils developed on moderately calcareous, loamy recent alluvium. The topography is level and vegetation is balsam poplar, aspen, elm, ash, white birch and white and black spruce.

The Carrot soils have a thin Ah horizon which distinguishes it from the Nels series. This weak horizon development is the result of the slightly higher elevation providing a favourable environment for tree growth and decomposition of organic matter. The organic matter content is high on the surface and occurs in thin bands throughout the soil section. Silt loam is the dominant texture but stratification with layers of different textures ranging from fine sand to clay is characteristic. Iron mottling within 15 cm of the surface is characteristic. The Carrot soils are only found within the Saskatchewan River delta. A typical Carrot series is described below.

Ahgj1 - 0-15 cm, very dark gray (10YR 3/2 moist) grayish brown (10YR 5/2 dry) silty clay loam; moderate fine granular; moist friable, dry slightly hard; neutral; weakly calcareous; abrupt smooth boundary.

Ckgj1 - 15-39 cm, gray (10YR 5/1 moist) brown (10YR 5/3 dry)silt loam; few fine faint yellowish brown (10YR 5/6) mottles; weak fine pseudo-platy breaking to weak fine granular; moist very friable, dry soft; mildly alkaline; moderately calcareous; abrupt wavy boundary.

Ckgj2 - 39-47 cm, dark gray (10YR 4/1 moist) brown (10YR 5/3 dry) silty clay loam, few fine faint dark brown to brown (7.5YR 4/2) mottles; moderate fine granular; moist friable, dry slightly hard; mildly alkaline; moderately calcareous; abrupt wavy boundary.

Ckgj3 - 47-66 cm, dark grayish brown (10YR 4/2 moist) light brownish gray (10YR 6/2 dry) silt loam; weak fine pseudo-platy breaking to weak fine granular; moist very friable, dry soft; mildly alkaline, moderately calcareous; abrupt wavy boundary.

Ckgj4 - 66-74 cm, very dark brown (10YR 3/2 moist) grayish brown (10YR 5/2 dry) silty clay loam; weak fine granular; moist friable, dry slightly hard; mildly alkaline; moderately calcareous; abrupt wavy boundary.

Ckgj5 - 74-98 cm, gray (10YR 5/1 moist) brown (10YR 5/3 dry) silt loam; weak fine pseudo-platy breaking to weak fine granular; moist very friable, dry soft; mildly alkaline; moderately calcareous.

TABLE 12.
Analysis of Carrot Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/ cm	$CaCO_3$ Equiv. %	Calcite %	Dolo-mite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
Ahgj1	0-15	SiCl	4	56	40	7.2	0.6	5.4	2.0	3.2	4.5	0.3	15.0	20.1	–	–	–	–	–
Ckgj1	15-39	SiL	2	73	25	7.6	0.4	14.2	7.0	6.6	1.2	–	–	22.4	–	–	–	–	–
Ckgj2	39-47	SiCL	2	66	32	7.6	0.6	12.9	5.5	6.8	1.6	–	–	26.9	–	–	–	–	–
Ckgj3	47-66	SiL	5	74	21	7.6	0.5	14.1	7.1	6.4	–	–	–	20.2	–	–	–	–	–
Ckgj4	66-74	SiCL	1	63	36	7.6	0.6	13.1	7.1	5.6	–	–	–	27.2	–	–	–	–	–
Ckgj5	74-98	SiL	3	72	25	7.5	0.7	14.0	6.2	7.2	–	–	–	23.4	–	–	–	–	–

Mapping Unit

Soils of the Carrot series covers an area of 10 810 hectares which represents 0.85 percent of the total map area.

Catfish Point Series (Cp)

The Catfish Point series consists of a poorly to very poorly drained Terric Mesic Fibrisol developed on 40 to 120 cm of dominantly fibric Sphagnum and subdominant mesic forest peat. This soil is underlain by strongly calcareous sand and gravelly sediments within 120 cm of the surface. Areas of Catfish Point soils have depressional to level topography. Native vegetation consists of dominantly stunted black spruce; ericaceous shrubs and Sphagnum spp. moss.

Mapping Unit

The Catfish Point series occurs north of The Pas and accounts for 1 210 hectares or 0.09 percent of the map area.

Cayer Series (Ca)

The Cayer series consists of very poorly to poorly drained Terric Mesisols developed on 40 to 160 cm of mesic fen peat overlying moderately to strongly calcareous loamy to clayey lacustrine sediments. Little or no (less than 15 cm) Sphagnum moss mantles the mesic fen peat. Cayer soils occur in high nutrient (eutrophic), very poorly to poorly drained, depressional to level areas found throughout the map sheet. Native vegetation is dominantly sedges, reed grasses and meadow grasses and aquatic mosses; a woody herbaceous cover of willow and swamp birch occur in areas of better drainage.

Minor areas of the Howell series, a Terric Mesisol, sphagnic phase, may be included in some map units designated as Cayer series.

A representative profile of the Cayer series is described below:

Om1 -	0 to 30 cm, yellowish red (5YR 4/6 moist) moderately decomposed, non woody fibrous material composed of mosses, and sedgy herbaceous remains, very strongly acid.
Om2 -	30 to 80 cm, dark reddish brown (5YR 3/2 moist) moderately decomposed, non woody fibrous material composed of mosses and sedgy herbaceous remains, strongly acid.
Om3 -	80 to 90 cm, dark reddish brown (5YR 2/2 moist) moderately decomposed, nonwoody fibrous material composed of mosses and sedgy herbaceous remains, strongly acid, abrupt wavy lower boundary.
IICkg -	90+ cm, greenish gray (5GY 5/1 moist) clay, massive, sticky and very plastic wet, mildly alkaline.

FIGURE 14
Cattle grazing on a Cayer site in the Saskeram.

TABLE 13.
Analysis of Cayer Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	Rubbed %	pH 1N KCL	Cond. mmhos/ cm	$CaCO_3$ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyro-phos-phate Sol. %	Ash %
Om1	0-30	–	–	–	–	66	35	4.8	–	–	61.3	2.7	22.7	144.8	4.3	39.6	0.3	0.1	61.7	8.0	5.4
Om2	30-80	–	–	–	–	55	40	5.2	–	–	62.3	2.6	24.0	150.2	43.0	37.6	0.2	0.2	49.2	6.6	5.8
Om3	80-90	–	–	–	–	35	18	5.2	–	–	35.8	1.8	19.9	121.0	51.2	24.7	0.4	0.2	44.4	40.2	43.1
IICkg	90 +	C	13	38	49	–	–	7.5	1.3	11.4	–	–	–	–	–	–	–	–	–	–	–

Mapping Unit

The Cayer series is often associated in map units with soils of the Howell, Katimik, and Stead series. The Crane and Kircro series are similar, but are underlain by loamy till and sand respectively. The area represented by the Cayer series is 107 768 hectares, which is 8.43 percent of the map area.

Cedar Lake Series (Cl)

The Cedar Lake series are moderately well and well drained Orthic Gray Luvisol soils developed on moderately to strongly calcareous, clayey till. Numerous isolated pockets of extremely calcareous, loamy till occur within the clayey matrix of the parent material. Topography of these areas is gently undulating to undulating. Cedar Lake soils generally have slightly stony to moderately stony surfaces depending upon the degree of water working they have undergone. Because of their clay textured surfaces, permeability is impeded and can be slow to very slow. Runoff is slow. Spruce and aspen with some jack pine constitute the dominant vegetative cover on the Cedar Lake series. A representative profile of the Cedar Lake series is described as follows:

L-H -	5-0cm, dark reddish brown (5YR 3/4 moist) semi-decomposed; leaf litter; medium acid; clear wavy boundary.
Ae -	0-3 cm, pale brown (10YR 6/3 moist) silt loam; moderate medium platy; friable moist; medium acid; clear wavy boundary.
Bt -	3-15 cm, dark reddish brown (5YR 2.5/2 moist) clay; very weak medium columnar; friable moist; neutral; clear wavy boundary.
Ck1 -	15-45 cm, pale brown (10YR 6/3 moist) silty clay; moderate to strong medium subangular blocky; friable moist; mildly alkaline.
Ck3 -	120+ cm, brown (10YR 5/3 moist) silt loam; moderate to strong fine to medium subangular blocky; friable moist; mildly alkaline.

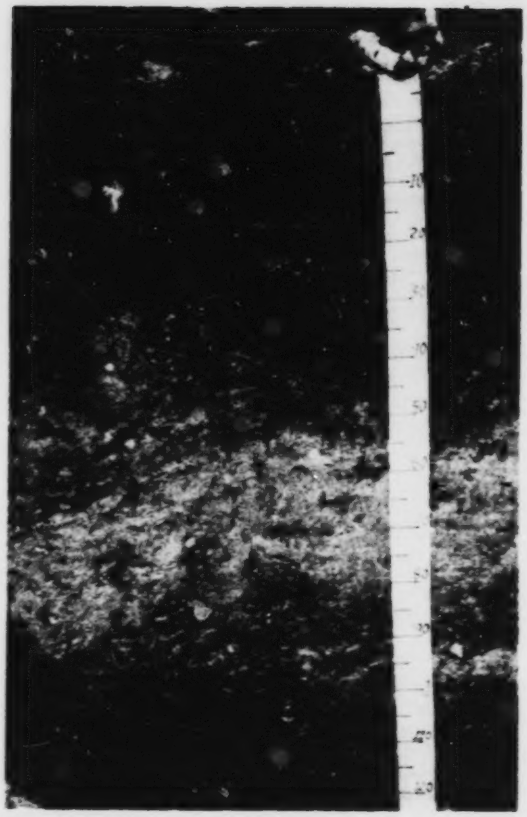


FIGURE 15

Soil profile of Cedar Lake, a Orthic Gray Luvisol developed on moderately to strongly calcareous clay till.

TABLE 14.
Analysis of Cedar Lake Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	5-0	—	—	—	—	5.6	—	—	—	—	50.8	1.5	33.8	110.4	53.8	19.1	2.7	0.1	34.7
Ae	0-3	SiL	32	53	15	6.0	0.3	—	—	—	2.2	0.1	22	18.6	7.6	3.7	0.2	0.1	7.0
Bt	3-15	C	16	26	58	6.6	0.3	—	—	—	1.3	0.1	13	38.5	17.9	11.8	0.6	0.1	8.1
Ck1	15-45	SiC	9	47	44	7.5	0.3	41.1	9.5	29.1	—	—	—	—	—	—	—	—	—
Ck2	45-120	SiC-SiCL	10	50	40	7.6	0.3	50.3	11.7	35.6	—	—	—	—	—	—	—	—	—
Ck3	120+	SiL	21	53	26	7.8	0.3	57.8	19.9	34.9	—	—	—	—	—	—	—	—	—

The Cedar Lake soils have a well developed solum, with a light gray Ae horizon overlying a dark grayish brown textural Bt horizon.

Cedar Lake soils were observed in the Overflowing River area and in the area between Clearwater Lake and The Pas, and to a lesser degree in the upper and lower Saskatchewan River delta. These soils are commonly associated with the Warpath series, the imperfectly drained member of the same soil association, and the Atikameg series, where pockets of extremely calcareous, loamy till occur.

The Cedar Lake soils of the Low Boreal climatic zone are the equivalent of the Homebrook soils found in the High Boreal Temperate climatic zone of this map area.

Mapping Unit

Soils of the Cedar Lake series cover an area of 16 971 hectares which represents 1.33 percent of the total map area.

FIGURE 16
Landscape picture of Chitek series in the foreground and the Dering series in the background.

FIGURE 17
Chitek and Dering sites on the ridges, and Crane and Dering peaty phase in the low swales on the Pas moraine.

Chitek Series (Ci)

The Chitek series are imperfectly drained Gleyed Eluviated Eutric Brunisol soils developed on extremely calcareous, loamy till. The surface texture is dominantly loam to clay loam. The topography ranges from nearly level to gently undulating. In areas with this latter class of topography the Chitek soils occupy the intermediate to lower slope positions, whereas in the smooth nearly level areas the Chitek soils are coincident with high groundwater tables. Runoff is slow and permeability is generally low to moderate. Stoniness varies from moderate to exceedingly stony in severely water worked Chitek areas having little or no lacustrine overlay. The native vegetation is dominantly aspen and spruce mixed with some balsam poplar, jack pine and willows. The following description is of a representative Chitek profile:

L-H -	7-0 cm, dark reddish brown (5YR 2/2 moist) moderately decomposed leaf litter; slightly acid; clear smooth boundary.
Aej -	0-2 cm, no sample
Bmgj -	2-8 cm, very dark grayish brown (10YR 3/2 moist) loam; very weak fine granular; very friable moist; neutral; clear wavy boundary.
Ckgj1 -	8-35 cm, very pale brown (10YR 7/3 moist) silt loam; massive; moist friable; mildly alkaline; extremely calcareous.
Ckgj2 -	35-86 cm, pale brown (10YR 6/3 moist) silt loam; moderate fine to medium subangular blocky moist firm; mildly alkaline; extremely calcareous.

Chitek soils have extremely thin, generally discontinuous eluvial (Ae) horizons or somewhat thicker Aej horizons overlying weakly developed Btj horizons.

Mapping Unit

The Chitek soils are often associated in mapping units with the Dering, peaty phase and Atikameg series, which are the poorly and well drained members of the same soil association. The area represented by the Chitek series is 48 425 hectares, or 3.79 percent of the map area.

Chocolate Complex (Chx)

The Chocolate complex consists of poorly to very poorly drained Terric Mesic Fibrisol, Terric Fibric Mesisol, and Terric Fibrisol soils developed on 65 to 160 cm of fibric Sphagnum moss which may be underlain by significant amounts of mesic forest and/or fen peat. These organic soils are underlain by loamy to clayey sediments within 120-160 cm of the surface. The topography is level to depressional. The vegetation is dominantly stunted black spruce and tamarack with an

TABLE 15.
Analysis of Chitek Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/ cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil				
															Ca	Mg	K	Na	H
L-H	7-0	—	—	—	—	6.4	—	—	—	—	52.2	1.2	—	167.9	95.6	36.6	0.9	0.1	34.7
Aej	0-2	No sample																	
Bmgj	2-8	L	35	45	20	7.3	1.1	4.4	0.4	3.7	2.4	0.1	24	—	—	—	—	—	—
Ckgj1	8-35	SiL	27	55	18	7.8	0.4	61.4	19.5	38.6	—	—	—	—	—	—	—	—	—
Ckjg2	25-86	SiL	22	58	20	7.8	0.3	64.9	22.0	39.5	—	—	—	—	—	—	—	—	—

TABLE 16.
Analysis of Chocolate Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	Fiber Content Rubbed %	pH 1N KCL	Cond. mmhos/cm	CaC0₃ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyrophosphate Sol. %	Ash %
Of1	0-20	–	–	–	–	92	66	6.2	–	–	51.8	0.9	60.2	86.8	40.3	13.9	1.5	0.5	30.8	7.5	6.8
Of2	20-30	–	–	–	–	84	52	6.5	–	–	57.6	1.2	48.4	76.3	52.4	13.1	1.0	0.5	20.0	5.5	8.1
Of3	30-75	–	–	–	–	72	36	5.3	–	–	59.9	1.4	42.2	112.8	53.2	24.4	0.3	0.5	32.5	4.8	6.3
Om1	75-120	–	–	–	–	66	24	5.4	–	–	62.6	2.0	31.4	131.5	77.4	22.2	0.1	0.4	36.7	8.6	5.8
Om2	120-235	–	–	–	–	42	14	5.6	–	–	63.4	2.0	31.1	146.8	92.4	21.6	0.1	0.3	37.8	17.2	6.8
IICkg	235-250	Si	4	81	15	–	–	7.4	0.4	14.1	0.9	–	–	23.32	–	–	–	–	–	–	–

understory of Sphagnum mosses and ericaceous shrubs.

Chocolate series, a Terric Mesic Fibrisol is the dominant soil in this complex. The Chocolate complex is found in the Mid Boreal climatic zone, and its equivalent in the Low Boreal climatic zone is the Molson complex also described later in this report. A detailed description of a representative Chocolate series is given below.

Of1 -	0-20 cm, brown to dark brown (10YR 4/3 broken); very pale brown (10YR 7/4 pressed) dark grayish brown (10YR 4/2 rubbed) spongy fibric Sphagnum moss; medium to fine fibered, nonwoody; slightly acid; unrubbed fiber content approximately 90%; rubbing to 66%.
Of2 -	20-30 cm, dark yellowish brown (10YR 4/4 broken wet); dark brown (10YR 3/3 pressed moist), yellowish brown (10YR 5/6 rubbed) fibric Sphagnum moss; medium to fine fibered, nonwoody; slightly acid; unrubbed fiber content approximately 84%, rubbing to 52%, clear wavy boundary.
Of3 -	30-75 cm, brownish yellow (10YR 6/8 broken), reddish yellow (7.5YR 8/6 pressed) yellowish brown (10YR 5/4 rubbed) Sphagnum moss and fen peat; medium to fine fibered, nonwoody; strongly acid; unrubbed fiber content approximately 72% rubbing to 36%; clear wavy boundary.
Om1 -	75-120 cm, dark reddish brown (2.5YR 2/4 broken), dusky red (2.5YR 3/2 pressed), dark reddish brown (5YR 3/4 rubbed) moderately decomposed, dominantly fen peat with forest peat inclusions; medium to fine fibered, nonwoody; strongly acid; unrubbed fiber content approximately 66% rubbing to 24%; gradual wavy boundary.
Om2 -	120-235 cm, black (10YR 2/1 broken), reddish brown (5YR 4/4 pressed), dark reddish gray (5YR 4/2 rubbed) moderately decomposed fen peat; fine fibered; nonwoody; medium acid; unrubbed fiber content approximately 42% rubbing to 14%; clear smooth boundary.
IICkg -	235-250 cm, greenish gray (5GY 6/1 moist), light gray to gray (5Y 6/1 dry) silt; massive; sticky wet; mildly alkaline; moderately calcareous.

Mapping Unit

The area mapped as Chocolate complex consists of 1 015 hectares or 0.08 percent of the total map area.

Crane Series (Cr)

The Crane series is composed of Terric Mesisol soils developed on 40 to 160 cm of mesic fen peat with less than 15 cm of fibric Sphagnum moss peat at the surface. Extremely calcareous, loamy, moderately stony till occurs within 160 cm of the surface. These poor to very poorly drained soils are located in high nutrient (eutrophic), depressional to level areas found throughout the map sheet. Native vegetation on these soils is sedge, brown moss, and reed grasses with interspersed clumps of swamp birch and willow.

Minor areas of the Waterhen series, a Terric Humic Mesisol, and the Halcrow series a Terric Mesisol, sphagnic phase, may be included in map units designated as Crane series. The Crane series is often associated in map units with soils of the Halcrow and Stead series.

The soils of the Crane series differ from the Cayer and Kircro series only in the nature of the underlying mineral substrate.

Mapping Unit

The area represented by the Crane series is 15 246 hectares, which is 1.19 percent of the map area.

Davis Point Series (Dp)

The Davis Point series are imperfectly drained Gleyed Dark Gray soils developed on moderately to strongly calcareous clayey till. Numerous

FIGURE 18
Treeless fen area and associated sedge vegetation characteristic of the Crane soils.

TABLE 17.
Analysis of Davis Point Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Each Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	5-0	–	–	–	–	6.5	0.4	1.9	–	–	39.5	1.83	21.6	–	–	–	–	–	–
Ahegj	0-5	C	10	30	60	6.5	0.3	00.4	–	–	5.1	0.28	18.2	43.3	21.4	20.5	1.3	0.2	2.1
Btjgj	5-15	C	12	25	63	7.0	0.3	4.2	–	–	1.7	0.11	15.5	30.8	–	–	–	–	–
BCkgj	15-20	C	10	25	65	7.3	0.3	17.1	00.0	15.7	00.8	0.05	16.0	25.5	–	–	–	–	–
Ckg1	20-60	C	11	30	59	7.7	0.3	24.1	9.9	13.1	–	–	–	20.4	–	–	–	–	–
Ckg2	(pockets)	SiCL	–	–	–	–	–	65.0	19.6	41.9	–	–	–	–	–	–	–	–	–

pockets of extremely calcareous, loamy till occur at random within the clayey matrix of the parent material. Clay surface textures and the nearly level to gently undulating topography of these soils contribute to slow permeability and slow to moderate runoff. Vegetative cover on the Davis Point soils is dominantly aspen, spruce and balsam poplar with an understory of willows, shrubs and grasses. The surface may be slightly stony. A description of a representative Davis Point soil follows:

L-H - 5 to 0 cm, black (5YR 2/1, dry), leaf mat, partially to well decomposed leaf and shrub remains; neutral; clear, smooth boundary.

Ahegj - 0 to 5 cm, very dark gray (10YR 3/1, dry) with dark gray (10YR 4/1, dry) blotches, clay; few, medium, distinct mottles; moderate, medium granular; firm when moist, hard when dry; slightly acid; clear, smooth boundary.

Btjgj - 5 to 15 cm, dark gray (10YR 4/1, dry), clay; few, medium distinct dark brown mottles; strong, medium granular; firm when moist, hard when dry; neutral, abrupt, wavy boundary.

BCkgj - 15 to 20 cm, gray (10YR 5/1, dry), clay; moderate, medium granular; firm when moist, hard when dry; mildly alkaline; strongly calcareous; clear, irregular boundary.

Ckgl - 20 to 60 cm, gray (5Y 6/1, dry), clay; moderate, medium pseudogranular; firm when moist, hard when dry; mildly alkaline; strongly calcareous; separated by an abrupt, irregular boundary.

Ckg2 - pockets of white (2.5Y 8/2, dry), silty clay loam; moderately, fine pseudogranular; friable when moist, very hard when dry; strongly cemented when dry; extremely calcareous.

The Davis Point soils are slightly eluviated, as evidenced by the thin, slightly leached Ahe horizon and the presence of a dark grayish brown Btj horizon. These soils are slightly acid in the A horizon and neutral in the B horizon.

Areas of Davis Point soils are found mainly in the southwest corner of the mapsheet around and between the Big Bog and Red Deer Lake. They commonly occur in association with soils of the Inwood series and the Sagemace series, peaty phase.

The Davis Point series of the High Boreal-temperate climatic zone are similar in parent materials and drainage to the Warpath soils of the Low Boreal climatic zone, which also occur in this map area.

Mapping Unit

The area mapped as the Davis Point series is 6 380 hectares, which represents 0.50 percent of the total map area.

Dering Series (Dr)

The Dering series consists of poorly drained Rego Gleysol, carbonated phase soils developed on extremely calcareous, stony, loamy till. These soils occupy level or depressional areas. Generally, Dering series are very stony, the degree of stoniness being dependant upon the presence or absence of a thin layer of mesic peat which can occur in this series. Internal drainage is very poor and runoff may vary from slow to nil. The dominant vegetation on these soils is black spruce, willows, ericaceous shrubs, sedges, feathermoss, and Sphagnum spp.. A description of a representative Dering series follows.

Om - 15 to 0 cm, black (10YR 2/1, dry), moderately decomposed woody and herbaceous materials; neutral.

IIAhg - 0-10 cm, grayish brown to dark brown (10YR 5/2 to 4/3 dry), very dark gray to very dark grayish brown (10YR 3/1, 3/2 moist), loam; amorphous breaking to weak medium granular; neutral; weakly calcareous.

IICkg - 10 to 60 cm, white to very pale brown (10YR 8/2 to 8/3 dry), pale brown (10YR 6/3 moist), silt loam; amorphous; mildly to moderately alkaline; extremely calcareous.

Profile development is limited, consisting of a thin grayish brown Ahg horizon overlying a gleyed Ckg horizon. The Dering series and Dering peaty phase occurs throughout the Low Boreal climatic region of the map sheet, usually in association with the better drained Chitek and Atikameg series. The Dering series and Dering peaty phase, correlates with the Meleb series and the Meleb peaty phase, of the High Boreal-temperate climatic zone.

Mapping Units

Dering series (Dr)

These areas consist dominantly of normal Dering series with small amounts of Dering peaty phase and Chitek soils. Area mapped is 17 044 hectares or 1.33 percent of the map area.

TABLE 18.
Analysis of Dering Series, Peaty Phase

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
Om	15-0	–	–	–	–	6.8	0.5	–	–	–	38.0	1.05	36	142.8	90.1	41.5	1.1	0.2	5.4
IIAhg	0-10	L	28	46	26	7.2	0.8	1.1	0.4	0.6	3.7	–	–	034.5	–	–	–	–	–
IICkg	10-60+	SiL	30	55	15	7.8	0.5	57.4	20.6	33.9	00.3	–	–	005.2	–	–	–	–	–

Dering peaty phase (Dr(P))

These areas consists dominantly of Dering soils having 15 to 40 cm surface layer of mesic peat. A small amount of normal Dering series may be present in this unit. Area mapped is 43 381 hectares or 3.39 percent.

Duck River (Dv)

The Duck River series consists of an imperfectly drained Gleyed Dark Gray soil developed on extremely calcareous, sandy to loamy lacustrine and deltaic deposits. Surface textures range from very fine sandy loam to silt loam. The topography of these areas are irregular, gently sloping. Runoff is moderate, and internal drainage is moderately permeable. These soils are stone free, but boulders and cobbles occur where the till is close to the surface. Native vegetation is balsam poplar, alder, willow, grasses and herbaceous plants. A representative profile of the Duck River Series is described below.

L-H -	2.5-0 cm, black (5YR 2/1 dry) dark reddish brown (5YR 3/2 moist), semi-decomposed organic matter, abrupt smooth boundary.
Ahe -	0-7 cm, very dark gray to dark gray (10YR 3/1-4/1 dry) very dark gray (10YR 3/1 moist) loam; pseudo-platy; moist friable; mildly alkaline; extremely calcareous; clear wavy boundary.
Bmgj -	7-20 cm, dark gray (10YR 4/1 dry) dark grayish brown (10YR 4/2 moist) loam; pseudoplaty breaking to weak fine granular; moist friable; neutral; moderately calcareous; clear wavy boundary.
Ckgj1 -	20-50 cm, pale brown (10YR 6/3 dry) light brownish gray to light gray (10YR 6.5/2 moist) silt loam; pseudoplaty; moist friable; mildly alkaline; extremely calcareous; clear wavy boundary.
Ckg2 -	50-75 cm, light brownish gray to light gray (10YR 6/2-7/2 dry) light yellowish brown to very pale brown (10YR 6.5/4 moist) silt loam; pseudo-platy; moist friable; mildly alkaline; extremely calcareous.

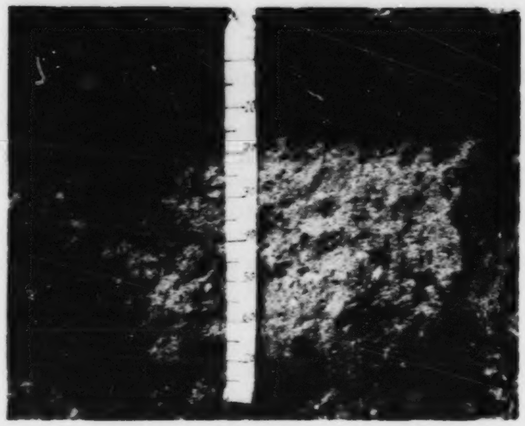


FIGURE 19
Soil profile of a Dering loam.

Ckg3 -	75+ cm, pale brown (10YR 6/3 dry) light gray (10YR 7/2 moist) silt loam; pseudo-platy; moist friable; moderately alkaline; extremely calcareous.

Mapping Unit

The Duck River Series is found on the levees along the Overflowing and Santon Rivers. The area mapped as Duck River series is 2 886 hectares, which is 0.23 percent of the map area.

Egg Island Series (Ei)

The Egg Island series consists of well drained Orthic Gray Luvisol, shallow lithic phase soils developed on thin moderately to strongly calcareous clayey lacustrine deposits underlain by extremely calcareous, loamy till. Limestone bedrock usually occurs within 50 to 100 cm of the surface. Topography of these areas varies from level

TABLE 19.
Analysis of Duck River Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	25-0	–	–	–	–	–	–	–	–	–	30.2	1.89	15.9	–	–	–	–	–	–
Ahe	0-7	L	34	42	24	7.9	0.39	0.6	0.2	0.4	7.2	0.40	18.0	17.0	–	–	–	–	–
Bmgj	7-20	L	41	37	22	7.2	0.39	14.0	2.8	10.3	1.5	0.14	10.7	19.4	–	–	–	–	–
Ckgj1	20-50	SiL	28	54	18	7.8	0.39	45.6	7.7	35.0	–	–	–	9.4	–	–	–	–	–
Ckgj2	50-75	SiL	20	59	21	7.7	0.39	49.9	13.4	33.7	–	–	–	9.2	–	–	–	–	–
Ckg3	75+	SiL	9	71	20	7.9	0.39	52.1	9.1	39.6	–	–	–	10.7	–	–	–	–	–

to gently sloping. These soils are slightly to moderately stony. Permeability is slow due largely to the clay surface texture of these soils. Runoff ranges from moderate to slow. Dominant vegetation includes aspen, spruce and jack pine.

The Egg Island soils have a dark grayish brown Ae horizon and a moderately developed textural B horizon. The Egg Island series occurs in isolated areas in the eastern portion of the map sheet. It is usually mapped in association with the Kinwow series, which is similar except for the lack of a lithic contact within the control section.

Mapping Unit

The area mapped as the Egg Island series is 994 hectares, which is 0.08 percent of the map area.

Easterville Series (Ea(P))

The Easterville series consists of poorly drained Rego Gleysol, carbonated, peaty phase soils developed on thin (25 to 100 cm) stratified, strongly calcareous sand and gravel deposits over extremely calcareous, loamy till. A thin (15 to 40 cm) layer of mesic peat blankets the surface of these soils. Runoff is very slow to nil. Internal percolation is impeded by a high groundwater table. These soils are moderately stony at the surface. The dominant vegetation on the Easterville soils is black spruce and willows with an understory of Labrador tea, Sphagnum, and feathermosses. A description of a representative Easterville, peaty phase soil is as follows:

Om1 -	38 to 33 cm, moderately decomposed coarse fibered woody and herbaceous materials; neutral; clear, wavy boundary.
Om2 -	33 to 18 cm, moderately decomposed herbaceous and woody materials; slightly acid; gradual, wavy boundary.
Om3 -	18 to 0 cm, medium to fine fibered mixed peat; compacted; neutral; abrupt, smooth boundary.
IICkg -	0 to 46 cm, light brownish gray to pale brown (10YR 6/2 to 6/3, dry), dark gray to gray (10YR 4/1 to 5/1, moist), gravelly loamy sand; single grained; loose when moist, loose when dry; mildly alkaline; extremely calcareous; abrupt, smooth boundary.
IIICkg	46 to 60 cm, (10YR 5/1, moist), clay loam; amorphous; extremely calcareous; mildly to moderately alkaline.

Easterville, soils are generally developed on gently undulating to ridged beach and outwash deposits overlying ridged moraine till deposits. These soils occur predominantly along the southern edge of The Pas Moraine, in association with other series developed from similar materials, such as the Tremauden, Horseshoe Island, and Freshford complexes.

Mapping Unit

The area mapped as Easterville peaty phase is 1 296 hectares or 0.10 percent of the map area.

Fairford Series (Fd)

The Fairford series consists of well drained Eluviated Eutric Brunisol soils developed on extremely calcareous loamy till. These soils have gently undulating to undulating topography with dominantly loam to clay loam surface textures. Runoff and permeability are moderate. The Fairford soils are generally very stony with certain more severely water worked ridges being exceedingly stony. Native vegetation comprises aspen, spruce and jack pine.

The solum of a Fairford soil is generally less than 20 cm, characterized by a thin light colored Ae or Aej horizon overlying a thin weakly developed textural B horizon. A representative profile of the Fairford series is described below.

L-H -	2 to 0 cm, dark reddish brown (5YR 2/2, dry), undecomposed to moderately decomposed layer of pine needles; slightly acid; abrupt, smooth boundary.
Aej -	0 to 2 cm, grayish brown (10YR 5/2, dry), clay loam; weak, fine granular; friable when moist, slightly hard when dry; neutral; abrupt, smooth boundary.
Bt -	2 to 10 cm, dark grayish brown (10YR 4/2, dry), clay loam; moderate, fine granular; firm when moist, hard when dry; neutral; aburpt, smooth boundary.
BCk -	10 to 20 cm, grayish brown (10YR 5/2, dry), loam; moderate, fine, granular; friable when moist, slightly hard when dry; mildly alkaline; very strongly calcareous; abrupt, broken boundary, contains a stone line below the Btj horizon.
Ck1 -	20 to 30 cm, light gray (10YR 7/1, dry), clay; moderate, fine, granular; friable when moist, weakly cemented when dry; mildly alkaline; extremely calcareous; abrupt, smooth boundary.

TABLE 20.
Analysis of Easterville Series, Peaty Phase

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil				
															Ca	Mg	K	Na	H
Om1	38-33	–	–	–	–	6.6	–	–	–	–	–	–	–	106.3	64.5	21.6	1.9	5.9	6.8
Om2	33-18	–	–	–	–	6.2	–	–	–	–	–	–	–	127.8	66.9	31.4	1.2	11.3	10.8
Om3	18-0	–	–	–	–	7.1	–	1.9	0.4	1.4	24.2	1.48	16	185.3	100.4	31.6	0.1	10.6	3.8
IICkg	0-46	LS gravelly	82	13	5	7.7	2.4	57.0	32.7	22.4	00.9	00.6	15	–	–	–	–	–	–
IIICkg	46-60	CL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Ck2 - 30 to 60 cm, light gray (2.5Y 7/2, dry), clay loam amorphous, breaking to weak, coarse, pseudo platy; friable when moist, weakly cemented when dry; moderately alkaline; extremely calcareous.

Minor areas of the Garson series, an Orthic Gray Luvisol, may occur in areas designated as Fairford series . The Garson soils cannot be mapped separately due to the limited ground truth and map scale of a reconnaissance survey.

The Fairford soils are often associated in mapping units with the Inwood, and Meleb series, peaty phase. The Fairford series of the High Boreal-temperate climatic zone correlates with the Atikameg series of the Low Boreal climatic zone.

Mapping Unit

The area mapped as Fairford series is 1 497 hectares, or 0.12 percent of the map area.

Foley Series (Fo)

The Foley series consists of poorly drained Rego Humic Gleysol carbonated phase, soils developed on very strongly and extremely calcareous, loamy lacustrine sediments. Surface textures are very fine sandy loam, loam and silt loam and subsurface textures generally become coarser with depth. These soils are level to depressional with very slow surface runoff. While the soils are very permeable, internal drainage is impeded by a high water table. Native vegetation consists of sedges and reed grasses with clumps of willow and alder. On slightly better drained sites where surface water is able to move off slowly, the dominant species are mixed stands of balsam poplar with some black spruce.

Foley peaty phase soils have a thin (15 to 40 cm) organic surface layer comprised mainly of moderately well decomposed fen peat. A very dark gray, calcareous Ahg horizon occurs below the peaty surface. It is underlain by a traditional AC horizon, gradually fades into the strongly gleyed iron stained, extremely calcareous parent material.

Mapping Units

Foley Series (Fo)

These areas consist of normal Foley series with minor inclusions of Foley peaty phase.

Foley peaty phase (Fo(P))

These areas consist of Foley soils having 15 to 40 cm of mesic herbaceous peat layer, and minor inclusions of Foley series.

The Foley and Foley peaty phase, series are found around the Red Deer Lake area. The Foley and Foley peaty phase series accounts for 521 and 2 886 hectares, or 0.04 and 0.23 percent of the map area respectively.

Freshford Complex (Fx)

The Freshford complex is comprised of the rapidly to well drained Orthic Gray Luvisol (Woodridge Series), Orthic Eutric Brunisol (Kawinaw Series) and Eluviated Eutric Brunisol (Freshford Series) soils developed on stratified, strongly to extremely calcareous sand and gravel deposits.

The Freshford series is the dominant member of the complex. A thin loamy fine sand to sand surface mantle generally covers coarser substrate materials. The Freshford complex is associated with narrow, elongated, undulating beach ridges. Surface runoff from these soils is nil to very slow as these soils are very permeable and water percolates through them quite rapidly. The surface may have some stones. Native vegetation consists dominantly of jack pine with some spruce and aspen. A description of a representative Fairford series (Eluviated Eutric Brunisol) follows.

L-H - 4-0 cm, very dark brown to dark brown (10YR 4/2 - 3/3 dry), very dark gray to dark reddish brown (5YR 3/1 - 2/2 moist), partially decomposed organic matter, medium acid, abrupt smooth boundary.

Ae - 0-3 cm, light brownish gray (10YR 6/2 dry), grayish brown (10YR 5/2 moist) gravelly sandy loam; single grained; loose moist and dry; neutral; moderately calcareous; abrupt smooth boundary.

Btj - 3-7 cm, brown (10YR 5/3 dry) dark yellowish brown (10YR 4/4 moist) gravelly loam, weak fine granular; loose moist and dry; neutral; moderately calcareous; abrupt wavy boundary.

BCk - 7-17 cm, gray to light gray (10YR 6/1 dry) very dark gray (10YR 3/2 moist) very gravelly sandy loam; single grained; loose moist and dry; mildly alkaline; extremely calcareous; clear wavy boundary.

Ck1 - 17-30 cm, white to very pale brown (10YR 8/2 - 8/3 dry) brown to pale brown (10YR 5/3 - 6/3 moist) very gravelly loamy sand; single grained; loose moist and dry; moderately alkaline; extremely calcareous; clear smooth boundary.

TABLE 21.
Analysis of Fairford Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/ cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	2-0	—	—	—	—	6.5	0.4	2.1	—	—	30.6	0.89	34.4	—	—	—	—	—	—
Ae	0-2	CL	44	29	27	6.6	0.2	0.5	—	—	2.3	0.10	23.0	26.0	16.6	8.5	0.4	0.1	1.4
Bt	2-10	CL	41	26	33	7.1	0.2	1.8	—	—	1.5	0.18	8.3	30.4	18.1	12.8	0.4	0.1	—
BCk	10-20	L	37	45	18	7.6	0.3	35.9	5.2	28.3	1.8	0.16	11.3	16.3	—	—	—	—	—
Ck1	20-30	C	27	28	45	7.8	0.3	55.5	16.4	36.0	—	—	—	—	—	—	—	—	—
Ck2	30-60	CL	26	46	28	8.0	0.3	63.2	13.2	46.1	—	—	—	—	—	—	—	—	—

FIGURE 20
A disturbed Freshford gravel site.

FIGURE 21
A good depth of sand and gravel on a Freshford site on The Pas moraine.

TABLE 22.
Analysis of Freshford Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	4-0	—	—	—	—	5.7	0.48	—	—	—	31.7	1.05	30.2	78.8	44.6	16.9	2.5	0.2	12.2
Ae	0-3	GrSL	65	26	9	6.7	0.58	7.6	0.0	7.0	3.2	0.11	29.8	11.6	—	—	—	—	—
Btj	3-7	GrL	52	37	11	7.1	0.64	19.1	2.7	15.2	3.7	0.27	13.7	17.0	—	—	—	—	—
BC	7-17	VGrSL	61	34	5	7.6	0.85	65.9	0.0	60.8	3.1	0.23	13.4	3.4	—	—	—	—	—
Ck1	17-30	VGrLS	76	23	1	7.9	0.76	64.7	15.3	45.6	—	—	—	4.0	—	—	—	—	—
Ck2	30-40	VGrSL	67	30	3	7.7	0.76	64.7	0.0	59.7	—	—	—	8.0	—	—	—	—	—
Ck3	40-100	VGrS	87	12	1	7.8	0.40	69.8	25.3	41.0	—	—	—	1.7	—	—	—	—	—

Ck2 - 30-40 cm, gray to grayish brown (10YR 5/1 - 5/2 dry) very dark brown (10YR 3/3 moist) very gravelly sandy loam; single grained; loose moist and dry; mildly alkaline; extremely calcareous; clear smooth boundary.

Ck3 - 40-100 cm, white (10YR 8/2 dry) pale brown (10YR 6/3 moist) very gravelly sand; single grained; loose moist and dry; mildly alkaline; extremely calcareous.

Freshford soils have a thin brownish gray Ae horizon and a weakly developed Bm or Btj horizon. The degree of leaching or soil profile development depends upon slight differences in parent material and position on beach ridges. Woodridge soils are usually found on the intermediate slopes of the ridges. The Freshford series, an Eluviated Eutric Brunisol, occurs higher up on the ridges, while the Kawinaw series, an Orthic Eutric Brunisol, occurs on the crest of the ridges.

Soils of the Freshford complex occur on The Pas Moraine. Here the parent material is somewhat coarser, which inhibits Luvisolic soil development. Therefore the Freshford series, an Eluviated Eutric Brunisol, rather than the Woodridge series, an Orthic Gray Luvisol, is the dominant series.

Mapping Unit

Freshford soils are often associated in map units with soils of the Tremauden and Horseshoe Island complexes, and the Norris and Easterville series, peaty phase. The Freshford complex encompasses an area of 4 498 hectares, or 0.35 percent of the map area.

Grindstone Complex (Gdx)

The Grindstone complex encompasses poorly to very poorly drained organic soils developed on dominantly mesic forest peat. Extremely calcareous, loamy, moderately stony till occurs within 160 cm of the surface. A thin (0-65 cm.) layer of fibric Sphagnum moss peat may cap the surface. The topography of the Grindstone complex area is depressional to level. Dense stands of black spruce with an understory of ericaceous shrubs, Sphagnum and feathermosses are the dominant vegetation of these sites.

The dominant soil within the Grindstone complex is the Grindstone series, A Terric Mesisol with less than 15 cm of fibric Sphagnum peat at the surface.

The soils of the Lamb Lake complex are commonly associated with the Grindstone series. This is due to the hummocky nature of the Sphagnum moss layer overlying the mesic forest peat. These include dominantly the Lamb Lake series, a Terric Mesisol, sphagnic phase, with minor areas of the Mistatim series, a Terric Fibric Mesisol.

The soils of the Grindstone complex are similar to those of the Okno and Rat River complexes, differing only in the nature of the mineral substrate. Areas of Grindstone complex soils occur on The Pas Moraine, usually in association with soils of the Dering series peaty phase, and the Lamb Lake complex.

Mapping Unit

The area mapped as the Grindstone complex is 8 277 hectares, which is 0.65 percent of the map area.

Guy Hill Complex (Ghx)

The Guy Hill complex is composed of poorly to very poorly drained organic soils developed on 0 to 65 cm of fibric Sphagnum moss peat overlying dominantly mesic forest peat. These soils are underlain by strongly calcareous sandy sediments, within 160 cm of the surface. These underlying sandy sediments are mildly to moderately alkaline, and stone free. Areas of Guy Hill soils have level to depressional topography. Native vegetation consists of dominantly stunted black spruce and tamarack with an understory of dominantly Sphagnum mosses, sedges and ericaceous shrubs.

The Guy Hill series, a Terric Mesisol, sphagnic phase with a significant layer of 15 to 65 cm of fibric Sphagnum moss peat at the surface, is the dominant member of this complex. Other minor significant members of the Guy Hill complex are the Catfish Point series, a Terric Mesic Fibrisol; and the Pigeon Point series, a Terric Fibric Mesisol. The Rat River series, a Terric Mesisol with a thinner (0 to 15 cm) overlay of fibric Sphagnum peat, is also commonly associated with the Guy Hill complex. This is due to the hummocky nature of the discontinuous fibric Sphagnum moss overlying the mesic forest peat.

These organic soils correspond very closely to the Orok and Lamb Lake complexes, differing from them only in the nature of the mineral substrate.

Soils of the Guy Hill complex occur predominantly on the Pas Moraine, in association with soils of the Lamb Lake complex and the Easterville series, peaty phase.

Mapping Unit

The area mapped as Guy Hill complex is 3 476 hectares, which is 0.27 percent of the map area.

Halcrow Series (Hl)

The Halcrow series are very poorly drained Terric Mesisol, sphagnic phase soils developed on 15 to 65 cm of fibric Sphagnum moss peat overlying dominantly mesic fen peat. These soils are underlain by extremely calcareous, loamy, moderately stony till. The till contact occurs within 160 cm of the surface. The topography of these organic soil areas varies from depressional to level. Dominant vegetation consists of scattered thin stands of tamarack and some stunted black spruce with an understory of Sphagnum mosses, sedges and ericaceous shrubs.

The Halcrow soil profile closely resembles that the Howell differing from it only in the nature of the mineral substrate.

Mapping Unit

The Halcrow series occurs throughout the map area, often in association with soils of the Crane and Katimik series. The area represented by the Halcrow series is 5 907 hectares, which is 0.46 percent of the total map area.

Homebrook Series (Hb)

The Homebrook series are well drained Orthic Dark Gray soils developed on moderately to strongly calcareous clayey till, the matrix of this till is interspersed with randomly distributed pockets of extremely calcareous loamy till. The surface is clay textured and slightly to moderately stony. Topography of the Homebrook series is gently undulating to undulating. Runoff is moderate to slow and permeability is slow. The Native vegetation consists of aspen, spruce and balsam poplar. A Homebrook series profile description is given below.

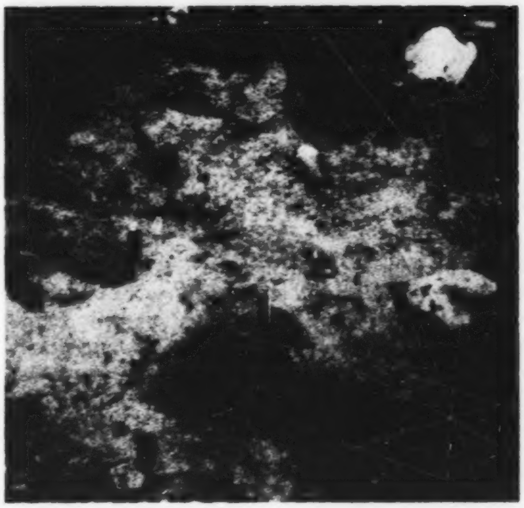


FIGURE 22

Ditch cut in Homebrook clay till with inclusions of high lime till (white areas).

TABLE 23.
Analysis of Homebrook Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/ cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil				
															Ca	Mg	K	Na	H
L-H	5-0	—	—	—	—	7.0	0.5	02.0	—	—	18.8	1.45	13.0	—	—	—	—	—	—
Ahe	0-10	C	06	28	66	6.5	0.3	00.4	—	—	03.0	0.33	09.2	43.5	30.4	06.1	1.3	0.2	1.6
AB	10-25	C	07	18	75	6.4	0.4	—	—	—	01.3	—	—	40.5	25.5	10.7	1.0	0.3	1.9
Bt	25-45	C	05	17	78	6.1	0.2	00.5	—	—	01.5	—	—	39.1	29.1	06.6	1.1	0.3	2.2
BC	45-56	C	04	36	60	7.4	0.3	07.5	03.1	04.1	01.0	—	—	—	—	—	—	—	—
IIC	56 +	C	14	36	50	7.6	0.3	38.8	24.4	13.1	—	—	—	—	—	—	—	—	—

Ahe - 0 to 10 cm, very dark brown (10YR 2/2 moist), gray to dark gray (10YR 4.5/1 dry), clay; moderate, fine granular; friable when moist, slightly hard when dry; neutral; clear, smooth boundary.

AB - 10 to 25 cm, very dark gray (10YR 3/1 moist), gray (10YR 5/1 dry), clay; moderate, medium granular; firm when moist, hard when dry; slightly acid; clear, wavy boundary.

Bt - 25 to 45 cm, very dark grayish brown (10YR 3/2 moist), dark gray to dark grayish brown (10YR 4/1.5 dry), clay; moderate, coarse granular structures breaking into strongly, medium to coarse subangular blocky aggregates; very firm when moist, very hard when dry; slightly acid; abrupt, wavy boundary.

BC - 45 to 56 cm, olive brown (2.5Y 4/4 moist), grayish brown (2.5Y 5/2 dry), clay; weak, coarse columnar structures breaking into moderate fine to medium subangular blocky aggregates; firm when moist, hard when dry; neutral; calcium carbonate concretions; abrupt, wavy boundary.

IIC - 56 cm plus, light olive brown (2.5Y 5/4, moist), light gray (2.5Y 7/2 dry), mixed loam and clay textured till; moderate, coarse granular; fir when most, hard when dry; mildly alkaline; very strongly calcareous.

Homebrook soils have a five to twelve cm dark gray Ahe horizon, underlain by a weakly developed dark grayish brown Bt horizon. A transitional BC horizon usually occurs in the lower portions of the clayey till.

Homebrook soils were observed in the area between the Big Bog and Red Deer Lake. This soil is most commonly associated with Sagemace series the poorly drained member of this association, and Davis Point and Inwood series the imperfectly drained members of this association. The Homebrook soils of the High Boreal Temperate climatic zone are developed on the same parent material as the Cedar Lake soils.

Mapping Unit

Homebrook series cover an area of 2 863 hectares which represents 0.22 percent of the area.

Homestead Series (Ho)

The Homestead series consists of Gleyed Cumulic Regosol soils developed on moderately to strongly calcareous stratified, loamy alluvial deposits with layers ranging from sand to clay in texture, and banded with dark colored layers of former surface horizons. Dominant texture in the profile are loams and silt loams.

The Homestead soils occur on stream terraces and the small fans which are forming from materials carried down from the bordering upland. The topography is level to gently sloping. The irregularity is caused by areas of shallow water courses and low levees. Surface drainage is good, particularly on the levees adjacent to the streams. Internal drainage is impeded by bands of fine textured layers in the profile and by a high water table in wet periods. Vegetation found on these sites are birch, ash, elm, white spruce and aspen. A description of a Homestead series is presented below.

L-H - 15-0 cm, very dark brown (10YR 2/2 dry) moderately decomposed leaf mat; slightly acid; abrupt smooth boundary.

Ckg1 - 0-20 cm, grayish brown (10YR 5/2 dry), silt loam; few fine faint mottles, weak fine granular; friable moist, soft dry; very strongly calcareous; abrupt smooth boundary.

Hbg - 20-23 cm, moderately well decomposed leaf litter, abrupt smooth boundary.

Ckg2 - 23-33 cm, light browish gray (10YR 6/2 dry), loam; many fine distinct iron mottles; weak fine granular; friable moist, soft dry; mildly alkaline; strongly calcareous; abrupt smooth boundary.

TABLE 24.
Analysis of Homestead Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/ cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil				
															Ca	Mg	K	Na	H
L-H	15-0	—	—	—	—	6.1	0.3	—	—	—	41.6	2.2	19	—	—	—	—	—	—
Ckgl	0-20	SiL	7	78	15	7.4	0.3	27.0	9.0	16.5	1.9	0.2	10	—	—	—	—	—	—
Hbg	20-23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ckg2	23-33	L	45	45	10	7.4	0.2	22.0	6.3	14.5	1.0	0.1	10	—	—	—	—	—	—
Ckg3	33-43	LVFS	77	18	5	7.5	0.4	20.3	9.0	10.3	0.4	0.1	4	—	—	—	—	—	—
Ckg4	43-63	SiL	36	53	11	7.5	0.2	21.7	7.9	12.7	0.8	0.1	8	—	—	—	—	—	—
Ckg5	63-90	LFS	86	11	3	7.5	0.2	17.3	9.5	7.2	0.2	0.1	2	—	—	—	—	—	—

Ckg3 - 33-43 cm, pale brown (10YR 6/2 dry) loamy very fine sand; few fine faint iron mottles; single grained; loose moist and dry; mildly alkaline; strongly calcareous; abrupt smooth boundary.

Ckg4 - 43-63 cm, pale brown (10YR 6/3 dry), silt loam; weak fine granular; friable moist, soft dry; mildly alkaline; strongly calcareous; abrupt smooth boundary.

Ckg5 - 63-90 cm, very pale brown (10YR 7/3 dry) loamy fine sand; few fine faint iron mottles; single grained; loose moist and dry; mildly alkaline; strongly calcareous.

The Homestead series has one isolated occurence around the Red Deer Lake. The Homestead series differs from Carrot River series in not having a weakly developed Ah horizon. It is also finer textured than the coarse loamy Nels series.

Mapping Unit

The area mapped as Homestead series is 1 103 hectares, which is 0.03 percent of the area.

Horseshoe Island Complex (Hrx)

The Horseshoe Island complex encompasses imperfectly drained Gleyed Eluviated Eutric Brunisol and Gleyed Gray Luvisol soils developed on thin (25 to 100 cm), stratified, strongly calcareous sand and gravel deposits over extremely calcareous, loamy till. The dominant member is the Horseshoe Island series, a Gleyed Eluviated Eutric Brunisol. The associated minor member, a Gleyed Gray Luvisol, is the Arbakka series. Areas of Horseshoe Island complex soils are ridged to gently undulating in topography and are usually very stony at the surface. Surface runoff is moderate and permeability may vary from moderate to slow depending upon the depth to the underlying glacial till deposits. In addition, internal drainage is impeded to some degree by a high groundwater table. Spruce, jack pine and balsam poplar constitute the tree cover while sedges and meadow grasses compose the understory.

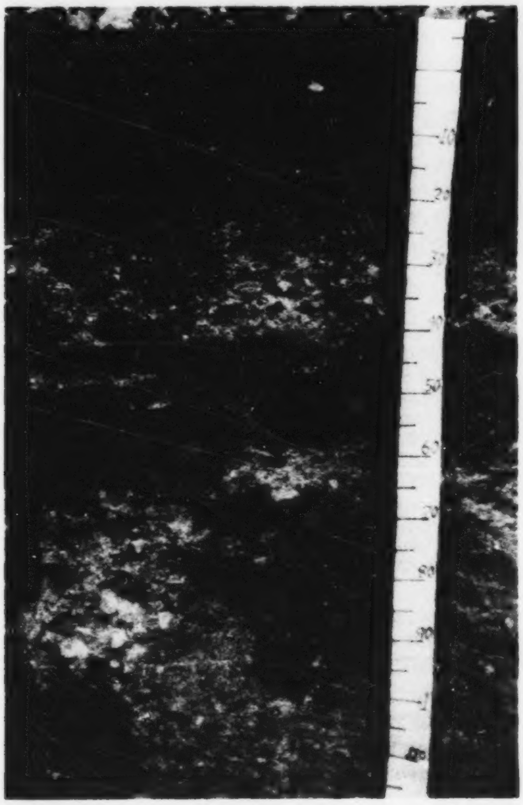


FIGURE 23
A soil profile of a Horseshoe Island soil, gravel over till.

Horseshoe Island soils usually have a light gray Ae horizon overlying a Bm or Btj horizon. The fragmental to sandy-skeletal texture of the surface deposits usually limits the development of an illuvial Bt horizon.

The parent material of these soils develops from till ridges which have undergone a degree of water sorting insufficient to produce deeper beach and outwash deposits. Horseshoe Island soils commonly occur in association with soils of the Freshford, and Soul Lake complexes and the Easterville series, peaty phase. These soils occur predominantly along The Pas Moraine.

Mapping Unit

Soils of the Horseshoe Island complex cover 3 544 hectares, which is 0.27 percent of the map area.

Howell Series (Hw)

The Howell series are very poorly to poorly drained Terric Mesisol, sphagnic phase soils developed on 40 to 160 cm of dominantly mesic fen peat underlain by moderately to strongly calcareous loamy to clayey lacustrine sediments. A mantle of 15 to 65 cm of fibric Sphagnum moss peat covers the surface. Howell soils occupy areas of depressional to level topography often occupying the swales in areas of ridge and swale topography. These soils support sedge-meadow plant communities in close association with Sphagnum mosses and some ericaceous shrubs. The overstory is dominantly tamarack occurring in thin, scattered stands along with some stunted black spruce.

The Bayton series, a Terric Fibric Mesisol with 15-65 cm of fibric Sphagnum moss peat overlying mesic fen peat, and the Cayer series, a Terric Mesisol with 0-15 cm of fibric Sphagnum moss overlying mesic fen peat, are commonly associated with mapping units of the Howell series. A description of the profile of a representative Howell soil follows:

Of - 0 to 30 cm, yellowish brown (10YR 5/6 moist) to very pale brown (10YR 7/4, moist), non-woody fibrous; spongy compacted or layered Sphagnum moss

TABLE 25.
Analysis of Howell Series

Horizon	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	pH .01M CaC12	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyro-phosphate Sol. %	Ash %	Bulk Density gms/cc.
Of	0-30	—	—	—	—	76	6.3	47.2	1.8	26	179.5	124.2	31.5	0.7	0.6	9.4	0.2	10.8	0.07
Om1	30-60	—	—	—	—	61	6.1	49.2	2.4	20	213.8	130.4	34.3	2.3	7.1	11.0	0.2	12.3	0.11
Om2	60-120	—	—	—	—	54	5.9	48.7	2.5	20	219.6	127.3	29.7	0.4	0.6	13.1	0.3	13.1	0.13
Om3	120-128	—	—	—	—	45	5.8	50.2	3.0	17	164.7	100.3	26.0	0.4	0.5	14.2	0.5	16.2	0.15
IIAhg	128 +	C	8	37	55	—	6.4	5.9	0.4	13	51.2	41.8	16.0	1.0	0.5	1.6	—	83.1	—

with woody instrusions (tamarack roots and stems) ; unrubbed fiber content approximately 76 percent; medium acid.

Om1 - 30 to 60 cm, very dark brown to dark reddish brown (10YR 2/2 to 5YR 3/3 moist), moderately decomposed, mixed woody and non-woody fibrous material composed of mosses, shrubby remains and herbaceous remains; becoming more herbaceous near bottom of layer; unrubbed fiber content approximately 61 percent; medium acid.

Om2 - 60 to 90 cm, dark brown (10YR 3/3, moist) moderately decomposed, medium fibered herbaceous material; matted and felt-like; unrubbed fiber content approximately 54 percent; medium acid.

Om3 - 90 to 120 cm, very dark brown (10YR 2/2, moist) moderately decomposed, medium fibered herbaceous material; matted or felt-like; unrubbed fiber content approximately 45 percent; medium acid.

IIAhg 120 to 128 cm, black (5Y 3/0, wet), light clay; strong fine granular; sticky and very plastic when wet; neutral; abrupt, wavy lower boundary.

IICg - 128 cm plus, light gray (5Y 5/1, wet), clay; massive; neutral to mildly alkaline.

The Howell soil profile closely resembles that of the Halcrow series, differing from it only in the nature of the mineral substrate.

Mapping Unit

The Howell series, covers some 9 756 hectares, or 0.76 percent of the map area.

Inwood Series (In)

The Inwood series are comprised of imperfectly drained Gleyed Dark Gray soils developed on extremely calcareous loamy glacial till. Surface textures range from loam to clay loam. Inwood soils have nearly level to gently undulating topography. Because of their occurrence on lower slope positions of low broad ridges and on smooth, nearly level terrain, these soils have slow runoff and moderate to slow permeability. The Inwood soils may vary from moderately stony to exceedingly stony at the surface depending upon the presence or absence of a thin lacustrine mantle (less than 15 cm) of fine loamy to clayey sediments over the till. The native vegetation includes spruce and aspen with some balsam poplar and willow. Meadow-prairie grasses and herbs form the ground cover. A representative Inwood profile is described as follows:

L-H - 1 to 0 cm, very dark brown (10YR 2/2, dry), leaf and sod mat; mildly alkaline; abrupt, smooth boundary.

Ahe - 0 to 8 cm, very dark gray (10YR 3/1, dry), with blotches of very dark gray to dark gray (10YR 3.5/1, dry), clay; weak, fine granular; friable when moist, slightly hard when dry; slightly acid; abrupt, wavy boundary.

Btjgj - 8 to 15 cm, dark gray (10YR 4/1, dry), clay; moderate, medium, granular; firm when moist, hard when dry; neutral; clear, smooth boundary.

BCkg - 15 to 20 cm, light brownish gray (2.5Y 6/2, dry), clay; weak, fine, granular; friable when moist, slightly hard when dry; mildly alkaline; strongly calcareous; clear, smooth boundary.

Ckg - 20 to 60 cm, light gray (2.5Y 7/2, dry), clay loam; weak, fine pseudogranular; friable when moist, hard when dry; mildly alkaline, extremely calcareous.

Inwood soils are characterized by a very thin A horizon overlying a thin, weakly developed textural B horizon. The total thickness of the solum is generally less than 20 cm.

Inwood soils occur in the High Boreal-temperate climatic zone, in the south western corner of the map area. These soils are similar to the Chitek series of the Low Boreal zone, which occurs throughout the northern portion of the map sheet. The Chitek series is an Eluviated Eutric Brunisol, and has a more strongly leached solum than the Inwood series.

TABLE 26.
Analysis of Inwood Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/ cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	1-0	—	—	—	—	7.5	0.5	1.4	—	—	30.7	1.61	19.1	—	—	—	—	—	—
Ahej	0-8	C	26	31	43	6.2	0.4	0.	—	—	12.9	0.79	16.3	56.3	34.5	18.7	1.2	0.1	0.8
Btjgj	8-15	C	28	27	45	6.7	0.3	0.8	—	—	2.6	0.17	15.3	22.3	16.9	3.5	0.9	0.2	1.3
BCkg	15-20	C	30	19	51	7.4	0.2	18.2	60.0	16.8	1.4	0.12	11.7	23.7	—	—	—	—	—
Ckg	20-60	CL	22	46	33	7.7	0.2	43.7	11.4	29.8	—	—	—	14.3	—	—	—	—	—

Mapping Unit

Inwood soils usually occur in association with the Meleb series. Inwood soils cover 48 425 hectares, which is 3.79 percent of the map area.

Katimik Series (Kt)

The Katimik series consists of very poorly drained Typic Mesisol, sphagnic phase soils developed on dominantly mesic fen peat. These very deep organic soils are underlain by undifferentiated materials, usually loamy to clayey lacustrine sediments, at depths below 160 cm. A thin layer of fibric Sphagnum moss peat 15 to 65 cm thick blankets the surface. Katimik soils occur in areas of depressional to level topography and have a very hummocky micro relief. Vegetation supported on these soils are stunted black spruce and tamarack, with dominantly Sphagnum moss and ericaceous shrub understory. A representative Katimik series profile is described below.

Of1 -	0-20 cm, reddish yellow (7.5YR 6.5/6 moist) dominantly fibric Sphagnum moss, medium to fine fibered, low wood content, extremely acid, unrubbed fiber content approximately 89% rubbing to 81%.
Of2 -	20-55 cm, brown to dark brown (7.5YR 4/4 moist) fibric Sphagnum moss, medium to fine fibered; non woody; very strongly acid; unrubbed fiber content approximately 88%, rubbing to 76%, clear wavy boundary.
Om1 -	55-160 cm, black (7.5YR 2/2 moist) dominantly moderately decomposed fen peat, coarse to very fine fibered, low wood; medium acid; unrubbed fiber content approximately 48%; rubbing to 33%; clear wavy boundary.
Oh1 -	160-180 cm, black (5YR 2/1 moist) dominantly fen peat; dominantly fine to very fine fibered with some coarse wood fragments; low wood; slightly acid; unrubbed fiber content approximately 32% rubbing to 9%; clear wavy boundary.
IICkg -	180 cm, gray (5Y 5/1 moist) silty clay; massive; very sticky wet; moderately alkaline very strongly calcareous.

Mapping Unit

Most of the Katimik soil are found around the Big Bog, in association with such soils as Stead, or Waskwei series. Soils of the Katimik series cover an area of 16 475 hectares, which is 1.29 percent of the map area.

Kilkenny Complex (Kx)

The Kilkenny complex comprises a group of organic soils developed on deep 65 to 160 cm of fibric Sphagnum moss peat generally underlain by significant layers of mesic forest and/or mesic fen peat. Extremely calcareous loamy, moderately stony till occurs within 160 cm of the surface. Areas of Kilkenny complex soils are characterized by depressional to level topography with associated poor to very poor drainage. Native vegetation on these soils is black spruce and some tamarack with an understory of Sphagnum mosses and ericaceous shrubs.

The dominant soil within the Kilkenny complex is the Kilkenny series, a Terric Mesic Fibrisol. Others are the Ferland series, a Terric Fibric Mesisol and the Elmore series, a Terric Fibrisol. Both of these soils are generally only of minor significance. These soils are very low in nutrients and medium to strongly acid. A representative Kilkenny series may be described as follows:

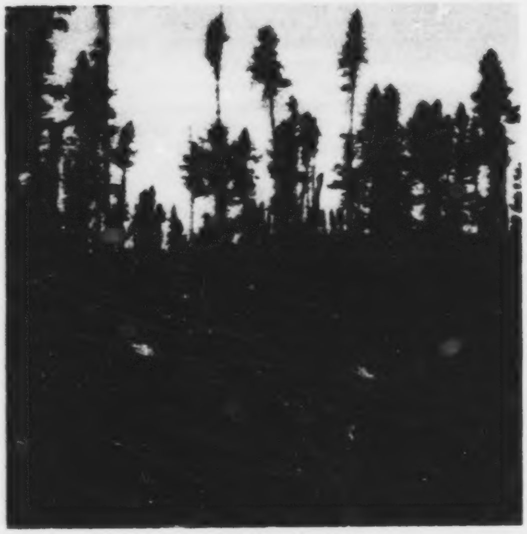


FIGURE 24

A Katimik soil site with associated stunted black spruce, ledum and Sphagnum spp.

TABLE 27.
Analysis of Katimik Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed/Rubbed %	%	pH 1N KCL	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyro-phos-phate Sol. %	Ash %
Of1	0-20	—	—	—	—	89	81	4.0	—	—	58.2	0.6	97.0	111.5	20.3	22.1	9.2	2.0	57.9	5.5	4.1
Of2	20-55	—	—	—	—	88	76	4.8	—	—	59.9	0.6	99.8	161.1	38.4	57.6	0.6	0.8	63.7	6.7	3.7
Om1	55-160	—	—	—	—	48	33	5.8	—	—	63.0	2.6	24.2	154.9	57.2	57.6	0.3	1.2	38.6	6.5	8.0
Oh1	160-180	—	—	—	—	32	9	6.3	—	—	50.2	2.1	23.9	179.8	74.4	68.5	0.4	1.8	34.7	38.0	25.0
IICkg	180 +	SiC	5	42	53	—	—	7.9	0.4	33.4	—	—	—	—	—	—	—	—	—	—	—

TABLE 28.
Analysis of Kilkenny Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	Fiber Content Rubbed %	pH 1N KCL	Cond. mmhos/cm	CaCO$_3$ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyro-phos-phate Sol. %	Ash %
Of1	0-50	–	–	–	–	99	91	3.6	–	–	55.4	0.3	184.7	123.9	20.0	7.7	1.4	0.3	94.5	4.7	5.8
Of2	50-85	–	–	–	–	84	70	4.4	–	–	58.3	0.8	72.9	150.1	50.6	24.7	0.4	0.1	74.3	8.1	6.0
Om1	85-110	–	–	–	–	11	4	6.2	–	–	42.2	1.0	42.2	209.8	136.2	36.6	0.1	0.1	36.7	165.0	22.8
IICkg	110 +	SiL	27	53	20	–	–	7.5	0.4	63.1	–	–	–	–	–	–	–	–	–	–	–

Of1 - 0-50 cm, reddish brown (5YR 4/4 moist) fibric Sphagnum moss; medium to fine fibered; non-woody; extremely acid; unrubbed fiber approximately 99% rubbing to 91%.

Of2 - 50-85 cm, strong brown (7.5 YR 5/6 moist) fibric Sphagnum moss; medium to fine fibered; non-woody; extremely acid; unrubbed fiber approximately 84% rubbing to 70%; clear wavy boundary.

Om1 - 85-110 cm, black (5YR 2/1 moist) moderately decomposed herbaceous forest peat; dominantly fine to very fine fibered with some coarse fibered wood fragments; low wood content; slightly acid; unrubbed fiber approximately 22%; clear smooth boundary.

IICkg - 110 cm +, light gray (10YR 7/1 moist) silt loam; massive; sticky wet; mildly alkaline; extremely calcareous.

The soils of the Kilkenny complex are similar to those of the Molson complex and the Sand River complex, differing from them only in the nature of the underlying mineral substrates, which are lacustrine clay and sandy sediments respectively.

The Kilkenny soils found in this map area, often occur in association with the Crane series and the Dering peaty phase series and Lamb Lake complex.

Mapping Unit

The area covered by soils of the Kilkenny complex is 10 686 hectares, or 0.84 percent of the map area.

Kinwow Series (Ki)

The Kinwow series are Orthic Gray Luvisol soils developed on 15 to 100 cm. of moderately to strongly calcareous clayey lacustrine deposits underlain by extremely calcareous loamy till. These well drained soils have clay surface textures. Their gently undulating to level topography and slow permeability contribute to a moderate runoff. Depending upon the thickness of the lacustrine clay mantle over the till, Kinwow soils may range from being slightly stony to moderately stony. The native vegetation is dominantly spruce and aspen with some balsam poplar and jack pine.

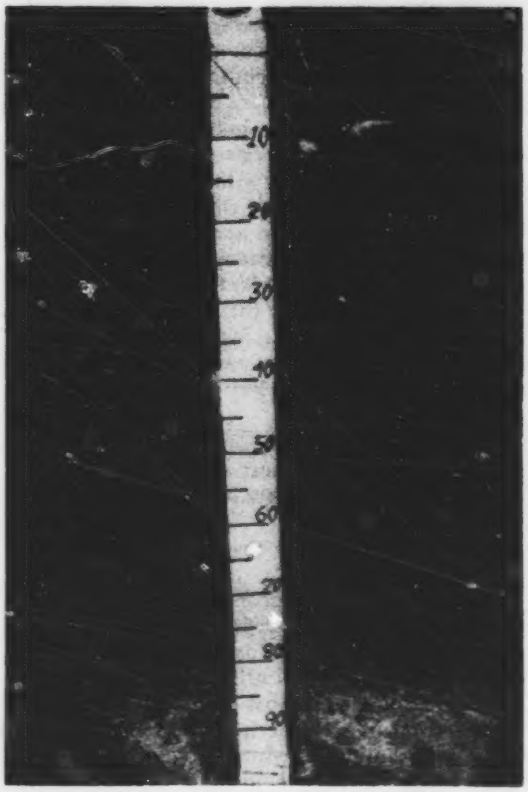


FIGURE 25
Soil profile of Kinwow, clay over high lime till.

TABLE 29.
Analysis of Kinwow Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M CaCl$_2$	Cond. mmhos/cm	CaCO$_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	2-0	–	–	–	–	6.2	–	–	–	–	33.6	.9	37.3	73.9	45.5	17.8	0.5	0.1	9.8
Ae	0-6	L	40	44	16	5.7	0.2	–	–	–	0.7	.1	7.0	11.6	4.1	2.1	0.2	Tr	5.0
Bt	6-30	C	10	24	66	6.1	0.3	–	–	–	0.8	.1	8.0	40.7	20.3	11.6	0.7	0.1	8.0
IICkg	30 +	SiL	34	51	15	7.9	0.3	68.6	42.2	24.3	–	–	–	–	–	–	–	–	–

A description of a representative Kinwow series as follows:

L-H - 2-0 cm, moderately decomposed leaves, needles and feathermoss; slightly acid; clear smooth boundary.
Ae - 0-6 cm, grayish brown (10YR 5/2 moist) loam; moderate fine platy; moist very friable; medium acid; gradual wavy boundary.
Bt - 6-30 cm, dark brown (10YR 3/3 exped moist) brown to dark brown (10YR 4/3 - 3/3 inped moist), clay; moderate to strong fine to medium subangular blocky; moist very friable; slightly acid; clear smooth boundary.
IICkg - 30+ cm, very pale brown (10YR 7/3 moist) silt loam; moderate to strong medium subangular blocky; moist very friable; moderately alkaline; extremely calcareous.

The Kinwow soils have a thin grayish brown Ae horizon overlying a weakly to moderately developed textural B horizon. The C horizon contains an increasing proportion of extremely calcareous loamy till as the depth increases. The contact between the clayey mantle and the underlying till is sometimes abrupt, indicating a lacustrine overlay. At other times the contact is gradual, as the till occurs in pockets within the clay, and the material appears similar to clay till.

Kinwow soils occur in and around the Clearwater Lake portion of the map area, often in association with soils of the Mantagao series.

The Kinwow series of the Low Boreal climatic zone correlate with the Arnes series of the High Boreal-temperate zone, as mapped in the soils of the Red Rose-Washow Bay Area (Soils Report No. 19)

Mapping Unit

The Kinwow soils cover an area of 1 395 hectares, which is 0.11 percent of the map area.

Kircro Series (Kc)

The Kircro series consists of very poorly to poorly drained Terric Mesisol soils developed on shallow (40 to 160 cm) deposits of moderately decomposed fen peat. Little or no (less than 15 cm) fibric Sphagnum moss occurs on the surface. The Kircro soils are underlain by strongly calcareous sandy or gravelly sediments within 160 cm of the surface. The Kircro soils occur in high nutrient (eutrophic), very poorly to poorly drained depressional to level areas. Native vegetation is dominantly sedges, brown mosses, and reeds, with willow and swamp birch occuring on local sites having better drainage.

Minor areas of Waldersee series, a Terric Humic Mesisol, and Sturgeon Gill series a Terric Mesisol, sphagnic phase may be included in some map units mapped as the Kircro series.

The Kircro series is often associated in map units with soils of the Sand River and the Whithorn complexes. The Cayer and Crane series are similar, but are underlain by clay and loamy till respectively. Kircro soils occur on the west central side of The Pas map sheet.

Mapping Unit

The area mapped as Kircro series is 15 515 hectares which is 1.21 percent of the map area.

Koostatak Series (Ko)

The Koostatak series consists of poorly drained Rego Humic Gleysol soils developed on moderately to strongly calcareous, clayey, lacustrine sediments. These soils are level to depressional with very slow surface runoff. The soils are very impermeable, but any internal drainage would be impeded by a high water table. These soil can also have a layer (15 cm) of mesic peat on the surface. Native vegetation consists of clumps of willows and alders with sedges, reed grasses and feathermoss forming the ground cover. On slightly better drained sites where surface water is able to move off slowly, the dominant species are mixed stands of balsam poplar and some black spruce.

Mapping Units

Koostatak series (Ko)

These areas consist of normal Koostatak series with minor inclusions of Koostatak peaty phase. The area mapped is 1 528 hectares or 0.12 percent of the map area.

Koostatak peaty phase (Ko(P))

These areas consist of Koostatak soils haveing 15 to 40 cm of mesic herbaceous peat layer, and minor inclusions of Koostatak series. The area mapped as Koostatak peaty phase is 3 089 hectares or 0.24 percent of the map area.

Lamb Lake Complex (Llx)

The Lamb Lake complex consists of poorly to very poorly drained organic soils developed on 0 to 65 cm of fibric Sphagnum moss peat overlying dominantly mesic forest peat. Areas of Lamb Lake complex are similar to those of the Grindstone complex, but have a thicker and more continuous layer of Sphagnum moss overlying the mesic forest peat. Extremely calcareous, loamy, moderately stony till occurs within 160 cm of the surface. Lamb Lake soils have depressional to level topography. Natural drainage of these soils is generally slightly more impeded than for the Grindstone soils. The dominant vegetation consists of unproductive stunted black spruce and tamarack with Sphagnum mosses, sedges and some ericaceous shrubs in the understory.

The dominant soil within the Lamb Lake complex is the Lamb Lake series, a Terric Mesisol, sphagnic phase. Other soils in the complex are the Kanusk series, a Terric Mesic Fibrisol; and the Mistatim series, a Terric Fibric Mesisol. The Grindstone series, a Terric Mesisol with a thinner (0 to 15 cm) surface layer of fibric Sphagnum peat, is also associated with the Lamb Lake complex.

FIGURE 26

A Lamb Lake soil site with associated black spruce and Sphagnum spp., along ditch cut on The Pas moraine.

This is due to the nature of the discontinuous hummocky, nature of the fibric Sphagnum moss overlying the mesic forest peat.

These organic soils correspond very closely to those described under the Orok and Guy Hill complexes, differing from them only in the nature of the mineral substrate.

Mapping Unit

Soils of the Lamb Lake complex occur mainly along The Pas moraine, often in association with the Dering peaty phase and Crane series Lamb Lake soils cover 35 422 hectares, which is 2.77 percent of the map area.

Le Pas Series (Lp)

The Le Pas series consists of soils developed on moderately calcareous, clayey stratified, recent alluvium. These soils are Rego Gleysols carbonated phase, having no significant horizon development. The topography is level and the vegetation is reeds and sedges.

These soils have a thin peat surface layer but the peat accumulation seldom exceeds 15 cm in thickness. In some soils the lack of organic accumulation on the surface is the result of frequent flooding. The flooding has retarded continuous organic matter production by covering the peat or muck with mineral sediments during the periods of inundation. As a result of these floods, the profiles are stratified with bands of peat or muck and the clay matrix is banded with thin layers of silty and sandy sediments. Reaction is variable throughout the profile, ranging from slightly acid to moderately alkaline. In general lower reactions are encountered in the layers containing an abundance of organic substances. Some salts are also found in this soil.

A typical Le Pas series is described below:

Ahg1 -	0-3 cm, dark grayish brown (10YR 4/2 moist) gray (10YR 5/1 dry) silty clay; weakly granular; moist firm; dry hard; neutral; abrupt wavy boundary.
Ahg2 -	3-34 cm, very dark grayish brown (10YR 3/2 moist) dark gray to very dark brown (10YR 4/1 - 3/2 dry) clay; weakly granular; moist friable, dry soft; neutral; clear smooth boundary.
Ckg1 -	34-56 cm, olive brown (2.5Y 4/4 moist) dark gray to grayish brown (10YR 4/1 - 5/2 dry) silty clay; few fine faint yellowish brown (10YR 5/5) mottles; moderate medium granular; moist friable; slightly hard; mildly alkaline; weakly calcareous; clear smooth boundary.
Ckg2 -	56-70 cm, very dark grayish brown (2.5Y 3/2 moist) light brownish gray (10YR 6/2 dry) silty clay loam weak fine pseudo-platy breaking to moderate fine granular; moist friable; dry slightly hard; mildly alkaline; moderately calcareous; abrupt smooth boundary.
Ckg3 -	70-100 cm, grayish brown (2.5Y 5/2 moist) brown to pale brown (10YR 5/3 - 6-3 dry) loam; weak fine pseudo-platy breaking to weak fine granular; moist friable; dry soft; mildly alkaline; moderately calcareous.

Mapping Unit

The Le Pas series is found only in the Saskatchewan River Delta, comprises a total of 8 909 hectares which is 0.70 percent of the map sheet.

Lettonia Series (Lt)

The Lettonia series consists of well drained Solonetzic Gray Luvisol soils developed on moderately to strongly calcareous lacustrine clay.

TABLE 30.
Analysis of Le Pas Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil					
															Ca	Mg	K	Na		H
Ahg1	0-3	SiC	1	42	57	7.0	1.3	—	—	—	7.2	0.5	14.4	46.6	32.5	12.9	0.8	1.3		—
															Soluble Salts meq/l sat. extract					
															Ca	Mg	Na	SO_4	Cl	HCO_3
Ahg2	3-34	C	1	29	70	6.6	3.1	—	—	—	7.4	0.6	12.3	—	25.3	17.2	4.3	43.6	0.7	2.3
Ckg1	34-56	SiC	0	35	65	7.4	2.8	3.4	1.7	1.6	1.5	—	—	—	24.3	14.0	3.4	38.5	1.4	2.3
Ckg2	56-70	SiCL	2	59	39	7.5	2.1	15.2	9.0	5.7	—	—	—	—	15.7	9.2	2.6	25.2	0.7	2.0
Ckg3	70-100	L	36	48	16	7.6	2.1	15.5	6.2	6.8	—	—	—	—	17.7	9.5	2.6	27.3	0.7	2.0

TABLE 31.
Analysis of Lettonia Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/ cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	5-0	—	—	—	—	5.0	0.43	—	—	—	23.3	0.9	25.0	59.0	27.2	7.9	0.2	0.3	23.5
Ae	0-3	C	11	39	50	5.1	0.30	—	—	—	2.5	0.2	14.0	19.3	9.8	2.5	0.5	0.2	6.3
AB	3-8	C	13	31	56	5.2	0.29	—	—	—	1.1	0.1	11.8	22.6	10.6	5.1	0.5	0.1	6.3
Bt	8-40	C	2	14	84	6.2	0.28	—	—	—	0.4	0.1	7.2	33.8	20.9	10.1	0.5	0.2	2.2
BC	40-65	C	9	19	72	5.5	0.17	—	—	—	0.7	0.1	8.6	28.8	15.8	8.3	0.6	0.2	3.9
Ckl	65 +	C	3	25	72	7.4	0.37	12.5	7.9	4.2	—	—	—	—	—	—	—	—	—

Topography is level to undulating. Surface drainage is moderate, while internal drainage is impeded because of texture and poor structure. The native vegetation is dominantly white spruce, aspen and jack pine. A representative profile is described below.

L-H - 5-0 cm, herbaceous leafmat; very strongly acid; abrupt smooth boundary.
Ae - 0-3 [illegible] light brownish gray (10YR 6/2 moist) light gray (10YR 7/1 dry) clay; moderate medium platy; moist friable; dry slightly hard; strongly acid; abrupt smooth boundary.
AB - 3-8 cm, dark gray (10YR 4/1 moist) light gray (10YR 7/2 dry) clay; strong coarse platy; moist firm; dry hard; strongly acid; clear smooth boundary.
Bt - 8-40 cm, dark brown (10YR 3/3 moist) grayish brown (10YR 5/2 dry) clay; strong medium to coarse columnar breaking to strong coarse blocky; moist very firm, dry very hard; slightly acid; clear smooth boundary.
BC - 40-65 cm, brown to dark brown (10YR 4/3 moist) grayish brown (10YR 5/2 dry) clay; massive; moist firm, dry hard; medium acid; clear smooth boundary.
Ck1 - 65+ cm, grayish brown (10YR 5/2 moist) very pale brown (10YR 7/3 dry) clay; massive; moist firm; dry hard; mildly alkaline; moderately calcareous.

A characteristic feature of the Lettonia soil profile is the columnar structure of the B horizon. A very thin light gray coating occurs on the upper portion of the columns. A thin light gray Ae horizon overlies the B horizon. The columnar aggregates grade into massive clay in the lower part of the B horizon.

Mapping Unit

The occurence of Lettonia is very low and accounts for 158 hectares or 0.01 percent of the area.

Limestone Point Series (Li)

The Limestone Point series are composed of well drained Eluviated Eutric Brunisol soils developed on thin (20 to 100 cm) extremely calcareous, loamy glacial till deposits over limestone bedrock. Loam to clay loam is the dominant surface texture of these soils. Topography is gently undulating to undulating. Runoff is usually moderate. Permeability may be moderate to slow. The underlying limestone bedrock may hinder the permeability at specific sites, but on a larger scale the presence of cracks and fractures may increase soil permeability. The Limestone Point soils are usually very stony with exceedingly stony areas occurring on the more severely water worked portions of ridges or where the bedrock approaches the surface. The solum of Limestone Point soils is generally less than 20 cm, characterized by a thin light colored eluvial Ae or Aej horizon overlying a thin, weakly developed B horizon. Native vegetation is dominantly spruce and jack pine with some aspen.

Limestone Point soils of the Low Boreal climatic zone correlate with the Hilbre soils of the High Boreal -temperate zone.

Mapping Units

Limestone Point Series (Li)

These areas consist of normal Limestone Point series, ie., where the till veneer overlying the limestone varies in thickness from 20 to 100 cm in thickness.

Limestone Point shallow phase (Li(s))

These areas consist dominantly of Limestone Point soils having 10 to 20 cm of extremely calcareous loamy till over limestone bedrock. The pro-

FIGURE 27
Limestone Point shallow phase soil with 10-20 cm loamy till over bedrock.

file is a Eluviated Eutric Brunisol, microlitlic phase.

The Limestone Point and Limestone Point shallow phase series occurs mainly in the north east corner of the map sheet, often in association with bedrock outcrops and soils of the Atikameg series. The total area represented by the Limestone Point series is 20 422 hectares, and 14 286 hectares for the Limestone Point shallow phase, which accounts for 1.60 percent and 1.12 percent of the map area respectively.

Mantagao Series (Mg)

The Mantagao series consists of imperfectly drained Gleyed Gray Luvisol soils developed on 15 to 100 cm of moderately to strongly calcareous clayey lacustrine deposits overlying extremely calcareous loamy till. The topography is level to gently undulating. Due to the fine clay texture of the Mantagao series the permeability is slow. However, runoff is generally moderate. The surface may be slightly stony. Aspen and spruce with an understory of willow, feathermosses and sedges constitute the native vegetation. A representative profile is described below.

L-H - 13 to 0 cm, leaf and sod mat; neutral; abrupt, smooth boundary.
Ae - 0 to 5 cm, very dark gray (10YR 3/1, moist), clay; strong coarse to medium granular; firm when moist, hard when dry; neutral; abrupt, smooth boundary.
Bt - 5 to 18 cm, black (10YR 2/1, moist), clay; weak medium to coarse prismatic breaking to strong coarse to medium granular; firm when moist, very hard when dry; neutral; moderately calcareous; clear, wavy boundary.
BCkg - 18 to 30 cm, dark gray (5Y 4/1, moist), clay; moderate medium to fine granular; firm when moist, hard when dry; moderately alkaline; strongly calcareous; clear, smooth boundary.
Ckg - 30 to 60cm, gray (5Y 4/1, moist), clay; moderate medium to fine granular; firm when moist,hard when dry; moderately alkaline; strongly calcareous; abrupt, smooth boundary.
IICkg 60 to 76 cm, gray brown (2.5Y 5/2, moist), clay; weak medium blocky breaking to moderate coarse granular; firm when moist, hard when dry; moderately alkaline; strongly calcareous.

The solum of Mantagao soils is usually developed within the lacustrine veneer, and is generally clay textured and neutral to mildly alkaline. These soils have a thin brownish gray Ae horizon overlying a well developed Bt horizon. Mantagao soils of the Low Boreal climatic zone are similar to the less degraded Peguis soils of the High Boreal-temperate climatic zone mapped in the Waterhen Report.

Mantagao soils occur primarily in the northeast corner of the mapsheet. These soils are commonly mapped in association with soils of the Napanee Bay series, peaty phase, the Kinwow series, and the Chitek series.

Mapping Unit

Mantagao soils cover a total of 4 893 hectares, or 0.38 percent of the map area.

Marsh Complex (Mh)

The Marsh complex consists of dominantly Rego Gleysol, carbonated phase soils with minor inclusions of Rego Gleysol soils developed on thin mucky organic material and silty lacustrine deposits over extremely calcareous, loamy till. These very poorly drained soils occur in level to depressional areas that have been covered with water until recent times and that still are saturated for most of the year. Some areas may have numerous large boulders and cobbles scattered on the surface. Native vegetation of the Marsh complex soils is composed mainly of reeds, rushes and sedges.

Marsh complex soils generally have a thin layer of humic materials or mineral materials high in organic matter underlain by strongly gleyed olive gray mineral material.

Mapping Unit

These soils occur on low lying land in the map area. Total extent of Marsh complex soils is 15 931 hectares, or 1.25 percent of the map area.

Meleb Series (Ml)

The Meleb series comprises poorly drained Rego Humic Gleysol soils developed on extremely calcareous loamy till. These soils occupy level to depressional topographic positions and can be covered by a 0 to 15 cm thick mantle of mesic peat. The surface may range from relatively stone free in areas where a very thin lacustrine mantle ocurs over the till to exceedingly stony in areas with bed-

TABLE 32.
Analysis of Mantagao Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M CaCl$_2$	Cond. mmhos/cm	CaCO$_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil				
															Ca	Mg	K	Na	H
L-H	13-0	–	–	–	–	6.7	0.6	–	–	–	60.8	1.59	3.82	–	–	–	–	–	–
Ae	0-5	C	6	37	58	6.8	0.4	1.5	00.5	00.5	2.9	0.17	17.2	33.2	18.0	11.7	1.0	0.9	–
Bt	5-18	C	3	22	75	7.5	0.5	6.0	00.0	5.6	1.3	–	–	–	–	–	–	–	–
BCkg	18-30	C	2	28	70	8.0	0.4	20.8	6.5	13.4	–	–	–	–	–	–	–	–	–
Ckg	30-60	C	4	27	70	8.1	0.4	19.1	6.9	11.5	–	–	–	–	–	–	–	–	–
IICkg	60-75	C	13	23	64	8.1	0.4	22.4	11.3	10.5	–	–	–	–	–	–	–	–	–

TABLE 33.
Analysis of Meleb Series, Peaty Phase

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH Sat. paste	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil
Of-Om	24-4	–	–	–	–	6.7	0.5	–	–	–	53.2	2.75	19	113.9
Oh	4-0	–	–	–	–	7.1	0.5	1.1	00.4	00.7	13.8	1.10	13	43.6
IIAhkg	0-10	FSL	62	26	12	7.4	0.5	11.3	00.0	10.4	3.6	0.20	18	15.1
IICkg	10-50	SiL	17	52	21	7.9	0.7	48.6	14.8	31.2	–	–	–	11.0

rock present immediately below the control section (i.e. depths of 1-2 meters). High ground water tables in the Meleb soils impede permeability and runoff is slow to very slow. The dominant vegetation on these soils is willow and some black spruce with an understory of meadow grasses, sedges and feathermoss. A description of a representative Meleb, peaty phase soil is as follows:

Of-Om - 20 to 4 cm, dark brown to dark yellowish brown (7.5YR 3/2 to 10YR 3/4, moist), non-woody, fine fibered mixed sedge and moss peat; compacted; neutral; abrupt, smooth boundary.

Oh - 4 to 0 cm, black (7.5YR 2/0, moist), humus; amorphous to granular; compacted; neutral; abrupt, broken boundary.

IIAhkg - 0 to 10 cm, very dark gray brown (2.5Y 3/2, moist), sandy loam; weak, fine granular; friable when moist, soft when dry; mildly alkaline; moderately calcareous; abrupt, broken boundary.

IICkg - 10 to 50 cm, olive (5Y 5/3, moist), silt loam with yellowish brown (10YR 5/8, moist), mottles; amorphous breaking to weak fine granular; firm when moist, strongly cemented when dry; moderately alkaline; extremely calcareous.

Meleb soils throughout the southwest corner of the map area, often occur in association with soils of the Inwood, Crane, and Halcrow series. Meleb soils of the High Boreal-temperate climatic zone correlate with Dering soils of the Low Boreal climatic zone.

Mapping Units

Meleb Series (Ml)

These areas consist dominantly of normal Meleb series, with small amount of Meleb peaty phase soils.

Meleb peaty phase Ml(P)

These areas consist dominantly of Meleb soils having 15 to 40 cm of mesic peat surface, with minor occurrences of Meleb series.

The Meleb and Meleb peaty phase soils comprise 275 and 8 713 hectares respectively. These soils account for 0.02 and 0.68 percent of the area respectively.

Molson Complex (Mx)

The Molson complex comprises a group of very poorly drained shallow to thick organic soils developed on (65-160) fibric Sphagnum moss peat which may be underlain by significant amounts of mesic forest and/or fen peat. Moderately to strongly calcareous, loamy to clayey lacustrine sediments occur within 160 cm of the surface. Topography of these areas is depressional to level. Native vegetation associated with the Molson complex is dominantly stunted black spruce and tamarack with an understory of Sphagnum mosses and ericaceous shrubs.

The Molson series, a Terric Mesic Fibrisol, is the dominant soil in this complex. It has a fibric Sphagnum peat surface tier. The organic section is dominantly fibric Sphagnum peat underlain by sub-dominant layers of mesic forest and/or fen peat. Other soils in the Molson complex are the Sisib series, a Terric Fibric Mesisol and Sadlow series, a Terric Fibrisol. These soils are only of minor significance in the complex. A representative series of the Molson Complex, the Sisib series is described below.

Of - 0 to 66 cm, pale brown to brown (10YR 5/3 to 6/3, moist) non-woody; coarse fibered; fibric spongy Sphagnum moss; unrubbed fiber content approximately 99 percent; strongly acid.

Om - 66 to 92 cm, very dark brown to dark reddish brown (10YR 2/2 to 5Y 3/2, moist), mesic to humic, fine fibered to amorphous, granular material derived from mixed moss; woody and herbaceous material; neutral; unrubbed fiber content approximately 69 percent; considerable coarse woody material at contact of the upper layer.

IIAhg - 92 to 100 cm, black (2.5Y 3/0, wet), clay; strong, fine, granular; sticky, very plastic; slightly acid; abrupt, wavy boundary.

IICg - 100 cm, plus, light gray (5Y 5/1, wet) clay; compound; amorphous and weak, fine pseudo granular; sticky and very plastic when wet; neutral.

The soils of the Molson complex are similar to those of the Kilkenny and Sand River complexes,

TABLE 34.
Analysis of Molson Series

Horizon	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content (unrubbed) %	pH .01M $CaCl_2$	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyrophosphate Sol. %	Ash %	Bulk Density (gms/cc)
Of	0-66	–	–	–	–	99	3.0	57.9	0.52	111	126.7	12.5	8.8	0.7	2.3	110.7	0.08	4.1	–
Om	66-92	–	–	–	–	69	5.7	54.5	1.32	41	180.7	123.0	19.8	0.3	0.2	27.0	0.40	13.3	–
IIAhg	92-100	C	–	–	–	–	7.3	–	–	–	–	–	–	–	–	–	–	91.9	–
IICg	100 +	C	–	–	–	–	7.2	–	–	–	–	–	–	–	–	–	–	95.9	–

differing from them only in the nature of the underlying mineral substrate.

Molson complex soils are found throughout the map area and often occur in association with organic soils of the Cayer and Howell series and the Okno and Orok complexes.

Mapping Unit

Molson soils comprise a total of 51 560 hectares, or 4.03 percent of the map area.

Mukatawa Series (Mu)

The Mukatawa series consists of imperfectly drained, Gleyed Solonetzic Gray Luvisol soils developed on moderately to strongly calcareous lacustrine clay. They occupy topographic level to undulating sites. Surface drainage is moderate, while internal drainage is impeded due to texture, structure, and higher water table. The native vegetation is dominantly spruce and aspen with smaller amounts of balsam poplar present.

Mapping Unit

The Mukatawa series comprises 546 hectares, or 0.04 percent of the map area.

Napanee Bay Series, peaty phase (Nb(P))

The Napanee Bay series consists of poorly drained Rego Humic Gleysol, peaty phase soils developed on 15 to 100 cm of moderately strongly calcareous clayey lacustrine deposits underlain by extremely calcareous loamy till. Fifteen to forty cm of mesic peat generally blankets the surface of these soils. The depressional to level topography of the areas of Napanee Bay soils as well as their slow permeability commonly leads to water ponding after heavy rains or after snow melt in the spring. Runoff is very slow. Except for areas where the underlying extremely calcareous till rises close to the surface, the Napanee Bay soils are relatively stone-free. Native vegetation is dominantly solid black spruce and tamarack stands, with an understory of Labrador tea, Sphagnum and feathermosses. A representative profile is described below:

Of-Oh 40 to 0 cm, dark reddish brown (5YR 2/2, dry), matted, fibrous to moderately decomposed sedge peat; medium to fine fibered; neutral; abrupt, smooth boundary.

IIAhkg - 0 to 10 cm, dark gray (2.5Y 4/0, dry), silty clay, moderate medium, granular; very plastic when wet, firm when moist, slightly hard when dry; neutral; moderately calcareous; clear, irregular boundary.

IIACkg - 10 to 36 cm, gray (5Y 5/1, dry), clay; moderate, coarse granular; very plastic when wet, firm when moist, slightly hard when dry: mildly alkaline, very strongly calcareous; tongues into the IIC horizon ; abrupt, irregular boundary.

IIICkg 36 to 60 cm, light gray (5Y 7/1, dry), clay loam; few, medium distinct light yellowish brown mottles; amorphous; sticky when wet, hard when dry; mildly alkaline; extremely calcareous.

Napanee Bay soils generally have a surface layer of dark brown, slightly acid, moderately decomposed peat derived from sedges, herbaceous plants, and mosses. This organic layer is usually underlain by a thin, neutral to slightly alkaline, dark gray Ah horizon and a gleyed, moderately alkaline, gray Ckg horizon. Napanee Bay soils of the Low Boreal climatic zone correlate with the Partridge Creek soils of the High Boreal-temperate zone, mapped in the Waterhen Report.

Mapping Unit

Napanee Bay soils cover an area of 4 893 hectares, or 0.38 percent of map area.

Nekik Lake Complex (Nlx)

The Nekik Lake complex consists of imperfect to poorly drained Mesic Organic Cryosol and Fibric organic Cryosol soils developed on deep, perennially frozen forest peat or thin (65 cm) Sphagnum peat overlying mesic forest peat. The topography is level or irregular domes or palsas and peat plateaus. The vegetation is black spruce with an understory of Labrador tea and Cladonia.

The active layer is weakly decomposed fibric feathermoss peat. The frozen layer consists of feathermoss peat, which is moderately to moderately well decomposed.

A representative Nekik Lake series description is given below.

Of1 - 0-20 cm, dark red (2.5YR 3/6 broken) red (2.5YR 5/6 pressed) red (2.5YR 4/6 rubbed) fibric feathermoss, medium to fine fibered; non-woody; very stronly acid; unrubbed fiber content approximately 88% rubbing to 48%.

Of2 - 20-30 cm, dark reddish brown (5YR 2/2 broken) reddish brown (5YR 5/4 pressed) yellowish red (5YR 4/6 rubbed) moderately decomposed feathermoss; medium to fine fibered; non-woody; extremely acid; unrubbed fiber content approximately 76% rubbing to 24%; clear wavy boundary.

TABLE 35.
Analysis of Napanee Bay Series, Peaty Phase

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH .01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil
Of-Oh	40-0	—	—	—	—	7.0	0.5	2.0	—	—	52.0	3.01	17.3	—
IIAhkg	0-10	SiC	00	47	44	7.2	0.8	9.0	2.5	6.1	3.0	0.80	03.8	32.2
IIACkg	10-36	C	12	34	54	7.6	1.1	29.0	—	—	00.8	—	—	—
IIICkg	36-60	CL	24	48	28	7.8	0.6	61.0	20.9	36.9	—	—	—	4.7

TABLE 36.
Analysis of Nekik Lake Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	Fiber Content Rubbed %	pH 1N KCL	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Org. C %	Total N %	C/N Ratio	Each. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyrophosphate Sol. %	Ash %
Of1	0-20	–	–	–	–	88	48	4.7	–	–	61.0	1.8	33.9	118.0	10.4	12.4	0.4	0.3	99.5	28.0	6.7
Of2	20-30	–	–	–	–	76	24	4.0	–	–	58.8	2.4	24.8	165.5	62.0	20.4	0.1	0.2	87.6	29.0	5.6
Oh1	30-45	–	–	–	–	32	4	6.4	–	–	55.5	2.4	23.6	203.0	172.8	42.4	0.1	0.2	25.7	162.0	16.6
Ohz	45-50	–	–	–	–	24	4	6.4	–	–	55.0	2.0	27.6	216.5	42.4	48.0	0.1	0.4	19.4	143.0	16.4

Oh1 - 30-45 cm, black (5YR 2/1 broken) yellowish red (5YR 4/6 pressed) very dark gray (5YR 3/1 rubbed) well decomposed herbaceous peat; fine fibered with some coarse fibered wood; low wood, slightly acid; unrubbed fiber content approximately 32% rubbing to 4%; clear smooth boundary.

Ohz - 45-50+ cm, black (5YR 2/1 broken) dark reddish gray (5YR 4/2 pressed) very dark gray (5YR 3/1 rubbed) frozen; well decomposed herbaceous peat; fine to very fine fibered; non-woody; slightly acid; unrubbed fiber content approximately 24% rubbing to 4%.

Mapping Unit

A very small amount of Nekik Lake complex 913 hectares, is found at the top of the sheet in the Saskatchewan River delta and accounts for 0.07 percent of the map area.

Nels Series (N)

The Nels series consists of imperfectly drained Gleyed Cumulic Regosol soils developed on moderately calcareous coarse loamy textured recent alluvium. The topography is level. Vegetation on these sites consists of aspen, balsam poplar, willow and black spruce.

The Nels soils have a very weak or no profile development. On the prominent levees the soils show a darkening on the surface indicating incipient soil formation. Water soluable salts are low in concentration to absent. Both liminess and reaction are fairly uniform throughout the soil section, except in the areas of slightly better drained soils where some downward movement of lime has occured. Iron mottling is high throughout the profile.

A typical Nels series is described below.

Ckg1 - 0-17 cm, very dark grayish brown (10YR 3/2 moist) gray to light gray (10YR 6/1 dry) silt loam; common fine distinct dark brown to brown (7.5YR 4/4) mottles; weak fine granular; moist friable, dry slightly hard; mildly alkaline; moderately calcareous; abrupt wavy boundary.

Ckg2 - 17-22 cm, grayish brown (10YR 5/2 moist) light brownish gray to light gray (10YR 6/2-7/2 dry) very fine sandy loam; few fine faint yellowish brown (10YR 5/4) mottles; single grained; loose moist and dry; mildly alkaline; moderately calcareous; abrupt smooth boundary.

Ckg3 - 22-29 cm, dark gary (10YR 4/1 moist) light brownish gray (10YR 6/2 dry) silt loam; few fine distinct dark yellowish brown (7.5YR 4/4) mottles; moist very friable, dry soft; mildly alkaline moderately calcareous; clear smooth boundary.

Ckg4 - 29-32 cm, olive brown (2.5Y 4/4 moist) light brownish gray (2.5Y 6/2 dry) loam; few fine faint light olive brown (2.5Y 5/4) mottles; weak fine granular breaking readily to sin grained; moist very friable, dry soft; mildly alkaline; moderately calcareous; clear smooth boundary.

Ckg5 - 32-56 cm, dark grayish brown (2.5Y 4/2 moist) light brownish gray (2.5Y 6/2 dry) silt loam; few fine prominent light brown (7.5YR 6/4) mottles; weak fine pseudo-platy breaking to weak fine granular; moist friable, dry slightly hard; mildly alkaline; strongly calcareous; abrupt smooth boundary.

Ckg6 - 56-70 cm, olive brown (2.5Y 4/4 moist) grayish brown (2.5Y 5/2 dry) very fine sandy loam; few fine faint light olive brown (2.5Y 5/6) mottles; single grained to weak fine granular; moist very friable, dry soft; mildly alkaline; moderately calcareous; abrupt smooth boundary.

Ckg7 - 70-98 cm, dark grayish brown (2.5Y 4/2 moist) light brownish gray (2.5Y 6/2 dry) silt loam; weak fine pseudo-platy breaking to weak fine granular; moist friable, dry slightly hard; mildly alkaline; moderately calcareous.

Mapping Unit

The Nels series is only found within the Saskatchewan River Delta and is usually found mapped in association with the Big Lake series, Big Lake peaty phase or the Cayer series. The Nels series comprises 19 364 hectares, or 1.51 percent of the map.

TABLE 37.
Analysis of Nels Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Each. Cap. m.e./100 gm soil	Soluable Salts meq/1 sat. extract Ca	Mg	Na	SO_4	Cl	HCO_3
Ckg1	0-17	SiL	23	58	19	7.4	0.4	11.9	4.5	6.8	2.6	–	–	18.9	–	–	–	–	–	–
Ckg2	17-22	VFSL	68	24	8	7.5	0.3	12.1	4.4	7.1	0.6	–	–	8.1	–	–	–	–	–	–
Ckg3	22-29	SiL	10	71	19	7.5	0.4	14.3	6.8	6.8	–	–	–	22.1	–	–	–	–	–	–
Ckg4	29-32	L	42	49	9	7.6	0.4	14.1	8.2	5.4	–	–	–	10.8	–	–	–	–	–	–
Ckg5	32-56	SiL	1	82	17	7.7	0.4	15.8	7.6	7.5	–	–	–	19.7	–	–	–	–	–	–
Ckg6	56-70	VFSL	64	16	10	7.7	1.3	10.8	5.6	4.8	–	–	–	12.0	–	–	–	–	–	–
Ckg7	70-98	SiL	1	72	27	7.6	2.6	13.8	7.9	5.4	–	–	–	23.3	22.2	9.5	3.9	34.8	0.7	1.2

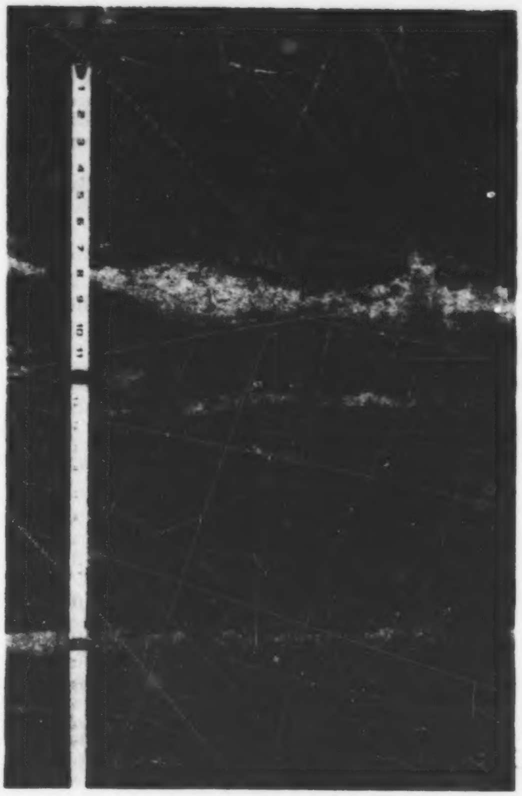


FIGURE 28
Soil profile of the coarse loamy Nels series.

Norris Series (Nr)

The Norris series are poorly drained Rego Gleysol, carbonated, phase soils developed on stratified, strongly calcareous sand and gravel deposits. These soils occupy level to depressional areas bordering gravelly beach ridges, and are generally covered by a thin (0 to 15 cm) blanket of mesic fen peat. Both runoff and permeability are very slow due to the lack of relief and the high groundwater table characteristic to areas of Norris soils The native vegetation is black spruce and some aspen, with an understory of Labrador tea and feathermoss.

A representative profile of the Norris peaty phase is given below.

Om1 - 25-15 cm, black (5YR 2/2 moist) moderately decomposed herbaceous and mossy material; extremely acid; clear smooth boundary.
Oh1 - 15-0 cm, black (5YR 2/1 moist) moderately well decomposed herbaceous and mossy material, neutral reaction; clear wavy boundary.
IIAhkg - 0-10 cm, very dark gray (5Y 3/1 moist) gravelly loam; single grained; slightly sticky wet, soft dry; neutral reaction, strongly calcareous; clear wavy boundary.
IICkg - 10+ cm, very pale brown (10YR 7/4 moist) very gravelly loamy coarse sand; single grained; nonsticky wet, loose dry; mildly alkaline; extremely calcareous.

Norris soils generally have a surface layer of very dark brown, slightly acidic, moderately decomposed peat overlying a gleyed, extremely calcareous Ckg horizon. A thin Ahkg horizon may occur above the C horizon. The Norris series, peaty phase is similar to the Easterville series, peaty phase, differing only in the lack of a till substrate within the control section.

Mapping Units

Norris series (Nr)

These areas consist of normal Norris series with minor inclusions of Norris peaty phase.

Norris peaty phase (Nr(P))

These areas consist of Norris soils having 15 to 40 cm of mesic herbaceous peaty layer, with minor inclusions of Rat River organic soils.

Norris and Norris peaty phase soils are found throughout the map area, often in association with soils of the Tremauden, Woodridge, Rat River, and Guy Hill complexes. Norris series, and Norrise peaty phase cover a total of 3 161 and 7 622 hectares or 0.25 and 0.60 percent of the map area respectively.

Novra Series (No)

The Novra series consists of poorly drained Rego Gleysol carbonated phase soils developed on moderately to strongly calcareous, loamy. Surface textures range from very fine sandy loam to silt loam. These soils are level to depressional with very slow runoff. Permeability is moderately rapid, but internal drainage is impeded by a high

TABLE 38.
Analysis of Norris Series Peaty Phase

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M CaCl$_2$	Cond. mmhos/ cm	CaCO$_3$ Equiv. %	Calcite %	Dolo mite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil					Fiber Content Unrubbed/Rubbed		Ash %
															Ca	Mg	K	Na	H	%	%	
Om1	25-15	–	–	–	–	4.2	–	–	–	–	58.3	1.0	58.3	117.5	32.5	14.9	1.5	0.1	68.5	74	48	10.7
Oh1	15-0	–	–	–	–	7.2	–	1.8	–	–	41.0	1.3	31.5	216.9	128.8	44.3	0.3	0.1	43.4	26	7	25.7
IIAhkg	0-10	GrL	51	37	12	7.3	0.4	19.2	2.4	15.5	3.1	0.2	15.5	–	–	–	–	–	–	–	–	–
IICkg	10+	VGr LCS	73	25	2	7.5	0.5	74.0	11.1	58.0	–	–	–	–	–	–	–	–	–	–	–	–

water table. Native vegetation is mainly black spruce, balsam poplar and willows.

The Novra soils have less than 15 cm organic surface layer, underlain by mineral substrata with a weak Ah horizon. There is usually a concentrated lime layer in the upper 15 to 30 cm's of soil. Buried surface horizons are common in the profiles. These soils are found along the Overflowing river in the area of the Big Bog.

Mapping Units

The Novra and Novra peaty phase soils comprise 1 276 and 1 874 hectares or 0.10 and 0.15 percent of the map area respectively.

Okno Complex (Ox)

The Okno complex is composed of a group of poorly to very poorly drained organic soils developed on mesic forest peat, frequently a thin (0 to 65 cm) discontinuous layer of fibric Sphagnum moss peat overlies the mesic forest peat. Moderately to strongly calcareous loamy to clayey lacustrine sediments occur within 160 cm of the surface. Okno areas are depressional to level. Permeability and runoff are very slow to nil on these soils. Native vegetation is dominantly black spruce with an understory of feather mosses, ericaceous shrubs and Sphagnum moss.

The dominant soils within the Okno complex is the Okno series, a Terric Mesisol with less than 15 cm of fibric Sphagnum peat at the surface.

The soils of the Orok complex are commonly associated with the Okno complex. This is due to the hummocky nature of the Sphagnum moss layer overlying the mesic forest peat. The soils of the Orok complex are similar to the Okno series , but possesses a thicker (15-65 cm) layer of fibric Sphagnum moss peat at the surface. These include dominantly the Orok series, a Terric Mesisol, sphagnic phase, with minor areas of the Kalevala series, a Terric Fibric Mesisol, and the Baden series, a Terric Mesic Fibrisol.

The profile of a representative Okno series may be described as follows:

Om1 -	0 to 15 cm, very dark brown to dark reddish brown (10YR 2/2, to 5YR 2/2, wet), amorphous granular; woody; unrubbed fiber content approximately 46 percent; neutral.
Om2 -	15 to 36 cm, very dark brown to dark brown (10YR 2/2, to 3/3, wet), mixture of coarse woody fibered and moderately coarse non-woody fibered mossy material; unrubbed fiber content approximately 64 percent; medium acid.
Om3 -	36 to 60 cm, very dark brown to dark reddish brown (10YR 2/2 to 5YR 2/2, wet), mixture of mossy, herbaceous and woody material; compacted; unrubbed fiber content approximately 63 percent; medium acid.
IIAhg	60 to 66 cm, black (2.5Y 2/1, wet), silty clay; massive, plastic and very sticky when wet; medium acid.

The soils of the Okno complex are similar to those of the Grindstone and Rat River complexes, differing from them only in the nature of the mineral substrate.

Mapping Unit

Okno soils occur often in association with soils of the Molson complex and the Orok complex and Howell series. Okno soils cover a total of 10 001 hectares, representing 0.78 percent of the map area.

Orok Complex (Orx)

The Orok complex consists of essentially the same group of poorly to very poorly drained organic soils as the Okno complex but differs from the latter in the dominance of specific member series. The areas mapped as Orok complex have a thicker and more continuous layer of Sphagnum moss overlying the mesic forest peat. Moderately to strongly calcareous clayey to loamy lacustrine sediments occur within 160 cm of the surface. The topography of Orok areas may be slightly more depressional than that of Okno areas and consequently natural drainage may be somewhat more impeded for the Orok soils. Native vegetation associated with Orok areas is largely stunted black spruce with some tamarack and an understory composed of Sphagnum mosses and ericaceous shrubs. A representative profile of the Orok complex is given below.

Of1 -	0-40 cm, strong brown (7.5YR 5/6 wet) fibric Sphagnum moss; medium to fine fibered; nonsticky; non woody; extremely acid; unrubbed fiber approximately 100% rubbing to 94%; clear wavy boundary.
Om1 -	40 to 100 cm, dark reddish brown (5YR 2/2 wet) moderately decomposed herbaceous forest; fine fibered with some coarse wood fragments non sticky; low wood; neutral; unrubbed fiber approximately 70% rubbing to 40%; clear wavy boundary.

TABLE 39.
Analysis of Okno Series

Horizon	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	pH .01M CaC	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./1000 gm soil					Pyro-phos-phate Sol. %	Ash %	Bulk Density (gms/cc)
												Ca	Mg	K	Na	H			
Om1	0-15	–	–	–	–	46	7.1	48.0	2.2	25	143.7	107.6	22.9	3.6	2.3	4.2	0.55	14.9	0.09
Om2	15-36	–	–	–	–	64	6.1	57.8	1.7	34	128.5	83.9	16.0	0.8	1.2	11.2	0.23	08.2	–
Om3	36-60	–	–	–	–	63	5.9	51.5	2.4	21	176.9	108.9	18.6	0.8	1.3	17.7	0.51	12.2	–
IIAhg	60-66	SiC	1	56	43	37	5.7	35.1	1.8	19	101.0	65.6	16.6	1.1	1.3	10.2	0.68	36.3	–

TABLE 40.
Analysis of Orok Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed/Rubbed %	%	pH 1N KCL	Cond. mmhos/ cm	CaC0$_3$ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyro-phos-phate Sol. %	Ash %
Ofl	0-40	–	–	–	–	100	94	4.0	–	–	61.7	0.5	123.4	131.5	22.2	31.7	4.1	0.2	73.3	4.1	4.3
Oml	40-100	–	–	–	–	70	40	6.6	–	–	58.2	1.2	48.5	191.9	93.1	60.7	0.2	0.3	37.6	21.1	9.1
Ohl	100-110	–	–	–	–	38	17	–	–	–	39.9	–	–	180.8	100.1	46.4	0.2	0.3	33.8	51.0	23.9
IICkg	110 +	C	6	27	67	–	–	7.5	–	1.1	–	–	–	51.3	25.7	15.6	0.8	0.2	9.0	–	–

Ohl - 100-110 cm, black (5YR 2/1 wet) moderately well to well decomposed herbaceous forest; dominantly fine to very fine fibered with some coarse wood fragments; slightly sticky; low wood; unrubbed fiber approximately 38% rubbing to 17%; abrupt smooth boundary.

IICkg - 110+ cm, dark grayish brown to grayish brown (10YR 5/2 moist) clay; massive; very sticky wet; very plastic; mildly alkaline; weakly calcareous.

The dominant soil within the Orok complex is the Orok series, a Terric Mesisol, Sphagnic phase, with a significant layer (15 to 65 cm) of fibric Sphagnum moss peat at the surface. Minor significant soils in the Orok complex include the Baden series, a Terric Mesic Fibrisol; the Kalevala series, a Terric Fibric Mesisol and the Okno series, a Terric Mesisol.

These organic soils correspond very closely to those of the Lamb Lake and Guy Hill complexes, differing from them only in the nature of the mineral substrate.

Mapping Unit

Soils of the Orok complex occur throughout the map area, frequently in association with the Napanee Bay series, peaty phase and the Okno and Molson complexes. Orok soils comprise a total of 12 059 hectares, or 0.94 percent of the map area.

Overflowing Series (Ov)

The Overflowing series consists of very deep organic soils developed on greater than 160 cm of saturated mesic fen peat with little or no (<15 cm) fibric Sphagnum peat at the surface. A hydric layer occurs between 40-130 cm. The Overflowing series is a Hydric Mesisol. These very poorly drained soils are generally underlain by strongly calcareous lacustrine clay in the Pas map sheet. These areas support dominantly sedges, reeds, and brown mosses. Minor areas of open water and the Stead series a Typic Mesisol may occur within some map units.

The Overflowing soils occur in very poorly drained areas and represent very late stages of lake filling and accumulation of organic deposit.

A representative description of an Overflowing series is given below.

Ofl - 0-25 cm, reddish gray (5YR 5/2 broken) dark reddish brown (5YR 3/3 pressed) dark reddish brown (5YR 3/2 rubbed), fibric sedge, and brown mosses; coarse to fine fibered; non-woody; neutral; unrubbed fiber approximately 68% rubbing to 52%; abrupt wavy boundary.

W - 25-130 cm, water layer; mesic material present in water; diffuse wavy boundary.

Oml - 130-175 cm, very dark brown (10YR 2/2 broken) brown to dark brown (10YR 4/3 pressed) very dark grayish brown (10YR 3/2 rubbed) moderately decomposed fen peat; medium to fine fibered, non-woody; slightly acid; unrubbed unrubbed fiber approximately 52%; rubbing 30%; clear smooth boundary.

IICkg - 175+ cm, greenish gray (5GY 5/1 moist) silty clay, massive, very sticky wet, moderately alkaline; moderately calcareous..

Mapping Unit

The Overflowing series is found mainly around the open waters of the Big Bog, and accounts for 11 597 hectares or 0.91 percent of the map area.

Pasquia Series (P)

The Pasquia series consists of poorly to very poorly drained Rego Gleysol, carbonated phase, soils developed on recent alluvium. The topography is level. The vegetation consists of reeds, sedges, willows and some aspen.

The Pasquia soils, like the other alluvial types have a thin layer of peat on the surface and have bands of peat within the profile. The solum is

TABLE 41.
Analysis of Overflowing Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed/Rubbed %	%	pH 1N KCL	Cond. mmhos/ cm	CaC0$_3$ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyro-phos-phate Sol. %	Ash %
Ofl	0-25	–	–	–	–	68	52	6.6	–	–	36.9	1.1	33.5	80.4	48.3	18.1	3.5	0.7	9.8	4.9	–
W	25-130		no sample																		
Oml	130-175	–	–	–	–	52	30	6.2	–	–	39.6	2.1	19.0	90.9	59.2	19.7	0.5	0.5	11.0	NS	–
IICkg	175 +	SiC	56	44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

moderately calcareous and moderately coarse in texture. Salinity varies between sites and from season to season. This variation is due to rapid changes in the groundwater level. When the water table is low, the salt concentration in the sandy surface layers is quickly lowered through the leaching effects of percolating rain waters. If the water table is kept at a low level soil salinity would not be a serious problem in a few years.

Mapping Units

Pasquia Series (P)

These areas consist dominantly of normal Pasquia soils. The area mapped is 6 075 hectares or 0.48 percent of the map area.

Pasquia drained phase (P(d))

These areas in comparison to the normal Pasquia series has improved surface drainage, a thinner layer of clay on the surface of the soil and less banding of finer textured sediments within the profile. The area mapped is 1 075 hectares or 0.08 percent of the map area.

Pasquia peaty phase (P(P))

These areas consist of Pasquia soils with 15-40 cm of mesic peat surface. A small amount of Pasquia series may be present also in this unit. The area mapped is 7 839 hectares or 0.61 percent of the map area.

These soils are only found in the Saskatchewan River delta. These soils occur in conjuction with the Nels and Cayer series.

Rat River Complex (Rrx)

The Rat River complex comprises a group of poorly to very poorly drained organic soils developed on mesic forest peat or thin (0 to 65 cm) fibric Sphagnum moss peat overlying mesic forest peat. Moderately to strongly calcareous sandy sediments occur within 160 cm of the surface. These underlying sandy sediments are usually moderately calcareous, mildly to moderately alkaline, and stone free. The areas of Rat River soils are level to depressional, often occurring adjacent to areas of better drained beach and outwash deposits. The dominant vegetation is black spruce with feather mosses, ericaceous shrubs and some Sphagnum moss in the understory.

The dominant soil within the complex is the Rat River series, a Terric Mesisol with less than 15 cm of fibric Sphagnum peat at the surface. The soils of the Guy Hill complex are associated with the Rat River complex, due to the thicker hummocky nature of the Sphagnum moss layer overlying the mesic forest peat in these areas. The Guy Hill complex include dominantly the Guy Hill series, a Terric Mesisol, sphagnic phase, with minor areas of the Pigeon Point series, a Terric Fibric Mesisol and the Catfish Point series, a Terric Mesic Fibrisol.

Soils of the Rat River complex are similar to those described under the Okno and Grindstone complex's, differing from them only in the nature of the underlying mineral sediments.

Mapping Unit

The Rat River complex is mapped in only a few localities, where it occurs in association with the Kircro, and Easterville peaty phase series. Rat River soils occupy a total of 8 096 hectares, or 0.63 percent of the map area.

Reed Lake Complex (Rex)

The Reed Lake complex consists of very poorly drained Terric Mesisols and Terric Mesisols sphagnic phase soils developed on 40-160 cm of mesic fen peat with dominantly little or no (< 15 cm) Sphagnum surface peat. These soils are very poorly drained and occupy level to depressional areas, and usually are underlain by loamy to clayey, moderately to strongly calcareous, sediments. The vegetation supported by these soils, are sedges and brown mosses.

The dominant soil of the complex is the Reed Lake series which is a Terric Mesisol. This soil is found in the Mid-Boreal climatic region and is equivalent to the Cayer series in the Low Boreal climatic region which is also described in this report. A representative profile of the Reed Lake series is presented below.

Of1 -	0-20 cm, dark grayish brown (10YR 4/2 broken) dark brown (10YR 3/3 pressed) dark brown (10YR 3/3 rubbed) fibric sedge and mosses, medium fibered; non-woody; neutral; clear way boundary.
Om1 -	20-85 cm, very dark brown (10YR 2/2 broken) very dark grayish brown (10YR 3/2 pressed) dark brown (7.5YR 3/2 rubbed) moderately to moderately well decomposed fen peat, medium to fine fibered; non-woody; medium acid; unrubbed fiber approximately 46%, rubbing to 12%, clear smooth boundary.
IICkg -	85+ cm light gray (5Y 7/1 moist) silt loam; slightly sticky wet; mildly alkaline.

Mapping Unit

This series occurs in one locality north of Moose Lake in the Saskatchewan River delta and covers an area of 669 hectares, or 0.05 percent of the map area.

Rock Island Complex (RIx)

The Rock Island complex consists of very poorly drained, Typic Mesisol sphagnic phase and Typic Mesisols on 160 cm of mesic sedge peat with dominantly little or no (0-15 cm) fibric Sphagnum surface. It is usually underlain by loamy to clayey textured, moderately to strongly calcareous sediments. The topography is depressional to level. The vegetation is dominantly sedges, reeds, brown mosses and scattered clumps of swamp birch.

The Rock Island series, a Typic Mesisol is the dominant soil in this complex. The Rock Island series is found in the Mid Boreal zone, and its

TABLE 42.
Analysis of Reed Lake Complex

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	Fiber Content Rubbed %	pH 1N KCL	Cond. mmhos/cm	CaC0₃ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyro-phosphate Sol. %	Ash %
Ofl	0-20		no sample																		
Om1	20-85	–	–	–	–	46	12	6.0	–	–	36.1	2.4	15.0	111.6	17.6	17.6	0.1	0.8	13.1	23.9	11.0
IICkg	85 +	SiL	10	71	19	–	–	7.4	.49	34	1.[illegible]	–	–	–	–	–	–	–	–	–	–

equivalent in the Low Boreal climatic zone is the Stead series, which is also described in this report.

A detailed description of a representative Rock Island series is given below.

Om1 -	0-20 cm, very dark brown (10YR 2/2 broken), dark brown (10YR 3/3 pressed), dark brown (10YR 3/3 rubbed) saturated moderately to moderately well decomposed fen peat; medium to fine fibered; non-woody; neutral; unrubbed fiber approximately 54% rubbing to 28%; clear wavy boundary.
Om2 -	20-100 cm, very dark brown (10YR 2/2 broken), dark brown (10YR 3/3 pressed) very dark grayish brown (10YR 3/2 rubbed) moderately well decomposed fen peat; medium to fine fibered; non-woody; slightly acid: unrubbed fiber approximately 48%, rubbing to 14%.
Om3 -	100-225 cm, very dark brown (10YR 2/2 broken), dark yellowish brown (10YR 4/4 pressed), dark brown (10YR 3/3 rubbed) moderately well to well decomposed fen peat; fine fibered; non-woody; medium acid; unrubbed fiber approximately 38%, rubbing to 10%; clear smooth boundary.
IICkg -	225+ cm, greenish gray (5GY 5/1 moist) silty clay; massive, very sticky wet; mildly alkaline; strongly calcareous.

Mapping Unit

This complex is found in one locality north of Moose Lake in the Saskatchewan River delta and covers an area of 11 597 hectares, or 0.91 percent of the map area.

Sagemace Series, peaty phase (Sm(P))

The Sagemace series comprises poorly drained Rego Humic Gleysol, peaty phase soils developed on moderately to strongly calcareous clayey till. The surface of these soils is generally clay textured and overlain with 15 to 40 cm of mesic peat. Topography of the Sagemace series is depressional to level. Fine textures and high ground water tables impede internal drainage and result in very slow permeability. Runoff is slow. The surface may have some stones depending upon the absence or presence of a thin lacustrine overlay. Vegetation is mainly meadow grasses and scattered willow clumps. In the northern portions of the soil zone the Sagemace soils supports fair closed stands of black spruce. A representative profile of the Sagemace series is described below:

Of-Om	15 to 0 cm, dark reddish brown (5YR 2/2, moist), non-woody fine fibered sedge and moss peat; compacted; slightly acid; mottled; abrupt, smooth boundary.
Ahg -	0 to 10 cm, very dark gray brown to very dark gray (2.5Y 3/2 to 10YR 3/1, moist), clay; weak, fine to medium granular; sticky and very plastic when wet, hard when dry; slightly acid; clear, wavy boundary.
IICg -	10 to 36 cm, dark gray to olive gray (5Y 4/1.5, moist), silty clay; weak, fine to medium granular; sticky and very plastic when wet, hard when dry; neutral; clear, wavy boundary.
IICkg1 -	36 cm. plus, dark gray to olive gray (5Y 4/1.5, moist), silty clay; weak coarse platy breaking to moderate fine subangular blocky ; sticky and very plastic when wet, hard when dry; neutral; very strongly calcareous; separated by an abrupt, broken boundary.
IICkg2 -	Pockets of light gray (2.5Y 7/2, moist), silty clay loam; weak coarse platy breaking to weak fine subangular blocky; slightly plastic when wet, hard when dry; mildly alkaline; extremely calcareous; some iron mottles.

The Sagemace soils usually have a layer of moderately decomposed peat at the surface, and a dark gray Ahg horizon overlying a gleyed Cg horizon. Numerous isolated pockets of extremely calcareous loamy till occur within the clayey matrix of the parent material.

The Sagemace, peaty phase soils of the High Boreal-Temperate climatic zone correlate with the Askakigau peaty phase of the Low Boreal climatic zone, which are also found in this map sheet

Sagemace soils occur most commonly in the southwest portion of the map area, near Lake Winnipegosis, where they are frequently associ-

TABLE 43.
Analysis of Rock Island Complex

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	Fiber Content Rubbed %	pH 1N KCL	Cond. mmhos/cm	CaC0₃ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyro-phosphate Sol. %	Ash %
Om1	0-20	–	–	–	–	54	28	6.8	–	–	53.1	2.7	19.6	–	–	–	–	–	–	6.1	7.6
Om2	20-100	–	–	–	–	48	14	6.4	–	–	57.3	3.1	18.5	–	–	–	–	–	–	8.2	8.0
Om3	100-225	–	–	–	–	38	10	5.8	–	–	60.6	2.7	22.9	–	–	–	–	–	–	8.1	22.1
IICkg	225 +	SiC	2	43	55	–	–	7.6	–	25.6	–	–	–	–	–	–	–	–	–	–	–

TABLE 44.
Analysis of Sagemace Series, Peaty Phase

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH Sat. paste	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil				
															Ca	Mg	K	Na	H
Of-Om	15-0	—	—	—	—	6.2	0.3	—	—	—	41.3	1.48	28	92.0	—	—	—	—	—
IIAhg	0-10	C	21	34	45	6.3	0.2	—	—	—	1.8	0.15	12	29.6	15.7	10.3	0.7	1.4	2.2
IICg	10-36	SiC	10	46	44	7.0	0.2	00.2	00.0	00.2	—	—	—	24.0	—	—	—	—	—
IICkg1	36 +	SiC	7	51	42	7.2	0.2	33.6	13.8	18.3	—	—	—	16.8	—	—	—	—	—
IICkg2	pockets	SiCL	10	60	30	7.3	0.2	64.5	35.4	26.9	—	—	—	1.9	—	—	—	—	—

ated in mapping units with soils of the Davis Point and Homebrook series.

Mapping Unit

Sagemace, peaty phase soils extend over an area of 5 441 hectares, or 0.43 percent of the total map area.

Saline Flats (Sfx)

Saline Flats consist of Rego Gleysol saline phase developed on poorly to very poorly drained recently exposed lake flats of saline, extremely calcareous medium textured till. These soils may be overlain by thin variably textured lacustrine deposits. Runoff and permeability are very slow. These soils are very stony.

The Saline Flats soils lack any discernible surface horizons. The soil material is usually calcareous to the surface and strongly gleyed and mottled. Saline Flats are usually bare of vegetation and have white encrustation of salts on the surface.

Mapping Unit

Saline Flats soils account for 350 hectares or 0.03 percent of the map area.

Sand Beaches (Sb)

Sand Beaches occur along the shores of Lake Winnipegosis. Beach materials may be in the form of low, recent sandy beach ridges presently in the process of formation along the shores of lake Winnipegosis. Frequently they are cobbly limestone and jumbled-rock admixtures molded into sharp crested ridges by the action of spring ice. They may be subsequently modified by wave-action. Beaches of this type are commonly located on the shores most directly exposed to the prevailing winds.

Sand beaches usually have little or no profile development and are of no agricultural or forestry value. Their dominant profile is the Orthic Regosol. Some sand beaches support scattered stands of willow, alder, and aspen.

Mapping Unit

Sand Beaches cover an area of 265 hectares, which represents 0.02 percent of the map area.

Sand River Complex (Srx)

The Sand River complex consists of poorly to very poorly drained organic soils developed on relatively thick (65 - 160 cm) fibric Sphagnum peat which may be underlain by significant amounts of mesic forest and/or fen peat. Moderately to strongly calcareous sandy sediments occur within 160 cm of the surface. These underlying sandy sediments are usually moderately calcareous, mildly to moderately alkaline, and stone free. Sand River areas are depressional to level. Native vegetation is dominantly stunted black spruce and tamarack with an understory of dominantly Sphagnum moss and ericaceous shrubs.

The Sand River series is the dominant soil of the complex, a Terric Mesic Fibrisol. The Turnberry series, a Terric Fibric Mesisol, and the Monkman series, a Terric Fibrisol, are the other members of the Sand River complex.

The Sand River soils are very comparable to the soils described under the Molson and Kilkenny complexes, differing from them only in the nature of the underlying mineral substrate.

Mapping Unit

Soils of the Sand River complex occur in only a few localities, often in association with Kircro and Stead series. These soils comprise a total of 11 387 hectares, or 0.89 percent of the map area.

TABLE 45.
Analysis of Long Point Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil				
															Ca	Mg	K	Na	H
L	8-6	—	—	—	—	6.6	—	—	—	—	49.0	1.3	—	124.9	71.8	34.0	2.6	0.1	16.4
F-H	6-0	—	—	—	—	6.9	—	—	—	—	30.6	1.0	30.6	122.3	77.8	32.4	1.4	0.1	10.6
Ae	0-7	LS	84	14	2	6.8	0.2	0.6	—	—	0.4	tr	—	5.3	2.8	1.2	0.1	< .1	1.2
Bt	7-22	FSL	83	2	15	6.9	0.2	0.7	—	—	0.4	tr	—	13.9	6.9	4.3	0.2	< .1	2.5
IICkl	22-50	VGrCS	91	6	3	7.5	0.3	67.7	11.4	51.9	—	—	—	—	—	—	—	—	—
IIICkl	50-90	SiL	26	52	22	7.7	0.3	58.9	16.6	39.0	—	—	—	—	—	—	—	—	—

Soul Lake Complex (Sox)

The Soul Lake complex consists of well drained soils developed on thin (25 to 100 cm), stratified, strongly calcareous, sand and gravel deposits overlying extremely calcareous, loamy glacial till.

The dominant member of the complex is the Soul Lake series, an Eluviated Eutric Brunisol. Other members are the Long Point series, an Orthic Gray Luvisol, and the Pim Lake series, an Orthic Eutric Brunisol. The Soul Lake series has a thin, light brownish gray Ae or Aej horizon overlying a weakly developed Bm or Btj horizon.

These soils are developed on glacial till landforms which have been waterworked, producing shallow beach and outwash deposits in the higher topographic positions. The fragmental to sandy-skeletal texture of these deposits inhibits profile development, and results in rapid runoff and moderate to rapid permeability. Native vegetation is jack pine with some black spruce and aspen. A representative description of a member of the Soul Lake complex (the Long Point series) follows.

L -	8-6 cm dark reddish brown (5YR 3/2 moist) undecomposed leaves and needles; neutral.
F-H -	6-0 cm, dark reddish brown (5YR 2/2 moist) slightly decomposed leaves and needles; neutral; clear smooth boundary.
Ae -	0-7 cm, gray to light gray (10YR 6/1 moist) loamy sand; structureless; moist loose; non-plastic; neutral; clear wavy boundary.
Bt -	7-22 cm, dark yellowish brown (10YR 4/4 moist) fine sandy loam; very weak fine granular moist friable; neutral; clear wavy boundary.
IICk1 -	22-50 cm, pale brown (10YR 6/3 moist) very gravelly coarse sand; structureless; moist loose; non-plastic; mildly alkaline; extremely calcareous; clear wavy boundary.
IIICk1 -	50-90 cm, light brownish gray to light gray (10YR 6.5/2 moist) silt loam; weak fine to medium subangular blocky; moist friable; mildly alkaline; extremely calcareous.

Mapping Unit

The Soul Lake soils occur mainly on The Pas Moraine. These soils often occur in association with soils of the Chitek series, and the Freshford complex. The area mapped as the Soul Lake complex is 1 936 hectares, or 0.15 percent of the map area.

Stead Series (Sd)

The Stead series consists of very deep organic soils developed on greater than 160 cm of mesic herbaceous peat with little (less than 15 cm) or no fibric Sphagnum peat on the surface. These very poorly drained soils are generally underlain by moderately to strongly calcareous loamy to clayey lacustrine sediments at depths below 160 cm. Stead soils, located in depressional to level areas, support a native vegetation which is dominantly sedges, reeds, brown mosses and meadow grasses with scattered clumps of swamp birch and willow.

The Stead series is a Typic Mesisol. Minor areas of the Overflowing series, a Hydric Mesisol, may occur within some map units represented by the Stead series. The Overflowing series usually occurs in areas occurring adjacent to open water.

A representative Stead series profile is described below.

Of -	0-20 cm, reddish brown (5YR 4/4 moist) brownish yellow (10YR 6/6 pressed), fibric sedge, reeds and brown mosses; coarse to fine fibered; non-woody; neutral; unrubbed fiber approximately 60%; rubbing to 45%; clear wavy boundary.

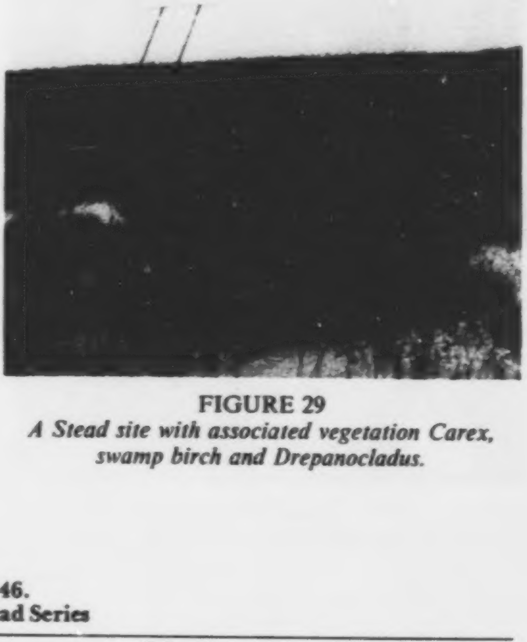


FIGURE 29
A Stead site with associated vegetation Carex, swamp birch and Drepanocladus.

TABLE 46.
Analysis of Stead Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	Fiber Content Rubbed %	pH IN KCL	Cond. mmhos/cm	CaC0₃ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H	Pyro-phos-phate Sol. %	Ash %
Ofl	0-20	–	–	–	–	60	45	7.0	–	–	57.0	1.5	85.5	104.2	67.8	33.2	0.2	0.1	2.9	6.3	6.7
Om1	20-150	–	–	–	–	55	22	6.3	–	–	60.7	3.6	16.9	100.4	57.4	23.3	tr	0.1	19.6	6.5	5.2
Om2	150-220	–	–	–	–	48	16	6.3	–	–	61.1	3.6	17.0	120.6	68.3	24.8	tr	0.1	27.4	16.7	7.8
Oh1	220-260	–	–	–	–	44	8	7.2	–	–	41.9	2.9	14.5	85.9	52.5	22.5	tr	0.1	10.8	16.6	24.0
IICkg	260 +	C																			

Om1 - 20-150 cm, brown to dark brown (7.5YR 4/4 moist) brown to dark brown (7.5 YR 4/2 pressed) moderately decomposed fen peat; medium to fine fibered; non-woody; slightly acid; unrubbed fiber approximately 55% rubbing to 22%.

Om2 - 150-220 cm, dark brown (7.5YR 3/2 moist) very dark grayish brown (10YR 3/2 pressed) moderately decomposed fen peat; medium to fine fibered; non-woody; slightly acid; unrubbed fiber approximately 48%; rubbing to 16%; clear wavy boundary.

Oh1 - 220-260 cm, very dark grayish brown (10YR 3/2 moist) very dark gray (10YR 3/1 pressed) moderately well to well decomposed fen peat; fine to very fine fibered; non-woody; neutral; unrubbed fiber approximately 44%; rubbing to 8%; abrupt smooth boundary.

IICkg - 260+ cm, greenish gray (5GY 5/1 moist) silty clay; massive, very sticky wet moderately alkaline; moderately calcareous.

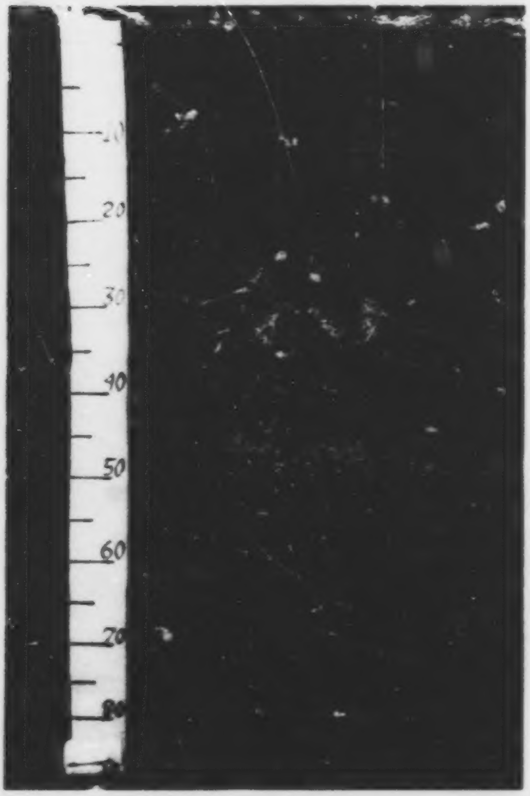


FIGURE 30
Soil profile of Tremauden sand and gravel.

Mapping Unit

Stead soils occur throughout the map area, often in pure mapping units or in association with organic soils of the Katimik, Waskwei or Overflowing series. Soils of the Stead series represent a total of 34 628 hectares, or 2.71 percent of the map area.

Swanford Series (Sf)

The Swanford series are Gleyed Rego Black soils developed on strongly calcareous, loamy lacustrine and deltaic deposits. Surface textures range from very fine sandy loam to silt loam. The topography is irregular, very gently to gently sloping. Runoff and permeability are both moderate. The dominant vegetation on these sites are aspen, balsam poplar, spruce, willow, sedges, and prairie grasses.

The Swanford series consists of soils with calcareous surface horizons underlain by strongly calcareous substrata. The textures usually become slightly coarser with depth.

Mapping Unit

The Swanford series occurs only once near Red Deer Lake in this map sheets and accounts for 521 hectares or 0.04 percent of the map sheet.

Tremauden Complex (Tux)

The Tremauden complex consists of imperfectly drained Gleyed Eluviated Eutric Brunisol (Tremauden series) and Gleyed Gray Luvisol (Sirko series) soils developed on strongly calcareous sandy to gravelly outwash and beach deposits. The Tremauden series is the dominant member of the complex. Generally a thin sandy surface mantle overlies the gravelly subsurface materials. These soils, common to the beach ridges associated with moraines and topographic highs have little surface runoff as the soils are quite permeable. Internal drainage is impeded by a high groundwater table. Some stones may appear at the surface. The native vegetation includes mainly spruce, white birch and jack pine with some balsam poplar. A typical Sirko series (Gleyed Gray Luvisol) profile is described below.

L-H - 3-0 cm, dark reddish brown (5YR 2.5/2 moist) moderately decomposed herbaceous material; very strongly acid; clear wavy boundary.

TABLE 47.
Analysis of Sirko Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	3-0	—	—	—	—	4.9	—	—	—	—	39.6	—	—	100.3	33.0	19.6	1.3	0.1	46.3
Aegj	0-5	LS	77	19	4	4.6	—	—	—	—	0.8	—	—	9.2	1.9	1.1	0.1	.1	6.1
Btgj	5-16	VGrSL	62	21	17	7.3	—	12.9	1.0	11.0	2.3	—	—	—	—	—	—	—	—
Ckgj1	16-70	VGrS	97	2	1	7.6	—	53.0	15.9	34.2	—	—	—	—	—	—	—	—	—
Ckg2	70+	FS	98	1	1	7.6	—	25.8	3.8	20.3	—	—	—	—	—	—	—	—	—

Aegj - 0-5 cm, gray to dark gray (7.5YR 4.5/0 moist) loamy sand; structureless; moist loose; non-plastic; very strongly acid; clear wavy boundary.

Btgj - 5-16 cm, dark reddish brown (5YR 3/4 moist) very gravelly sandy loam; structureless; moist very friable; neutral; moderately calcareous; gradual irregular boundary.

Ckgl - 16-70 cm, strong brown to reddish yellow (7.5YR 5.5/6 moist) very gravelly sand; structureless; moist loose; non-plastic; mildly alkaline; extremely calcareous; clear smooth boundary.

Ckg2 - 70+ cm, light yellowish brown (10YR 6/4 moist) fine sand; structureless; moist loose; non-plastic; mildly alkaline; strongly calcareous.

The Tremauden series is similar, but lacks sufficient movement of clay to produce a Luvisolic Bt horizon. Soils of the Tremauden complex occur throughout the map area, often in association with better drained soils of the Freshford complex and with the poorly drained Norris series, peaty phase.

Mapping Unit

Tremauden soils encompass a total of 2 694 hectares, or 0.21 percent of the map area.

Warpath Series (Wr)

The Warpath series consists of imperfectly drained Gleyed Gray Luvisol soils developed on moderately to strongly calcareous clayey till. Topography is nearly level to gently undulating. Permeability and runoff are slow to very slow due, in part, to clay textured surfaces of these soils. The surface may be slightly stony to moderately stony. The native vegetation of the Warpath series is dominantly spruce mixed with balsam poplar and aspen. A description of this series is given below.

L-H - 5 to 0 cm, leaf and sod mat; medium acid; abrupt boundary.

Ae - 0 to 8 cm, gray (10YR 6/1, moist), loam; coarse platy; slightly plastic when wet; strongly acid; abrupt boundary.

ABgj - 8 to 13 cm, grayish brown (10YR 5/2, moist), (dry), clay loam; coarse blocky; plastic when wet; strongly acid; clear boundary.

Btgj - 13 to 30 cm, dark gray (10YR 4/1, moist), clay; medium blocky; plastic when wet; strongly acid; clear boundary.

BCgj - 30 to 41 cm, dark grayish brown (10YR 4/2, moist), clay; medium blocky; plastic when wet; medium acid; slightly effervescent; gradual boundary.

Ckg - 41 to 51 cm, dark gray to gray (10YR 4.5/1, moist) silty clay; massive, slightly plastic when wet; mildly alkaline; very strongly calcareous; diffuse boundary.

Ckg2 - 51 cm plus, dark gray (10YR 4/1, moist) silty clay; coarse pseudogranular; plastic when wet; mildly alkaline, very strongly calcareous.

Warpath soils have a light gray Ae horizon underlain by a gleyed, textural B horizon. Numerous isolated pockets of extremely calcareous loamy till occur within the clayey matrix of the parent material .

Warpath soils of the Low Boreal climatic zone are similar in parent material and drainage to the

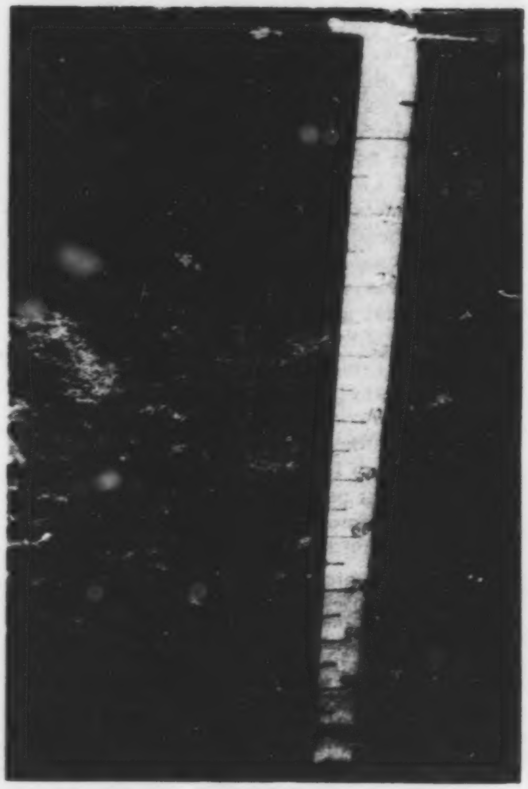


FIGURE 31
Soil profile of Warpath, clay till.

TABLE 48.
Analysis of Warpath Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH Sat. paste	Cond. mmhos/ cm	CaCO₃ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./ 100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	5-0	—	—	—	—	5.8	0.4	—	—	—	44.1	1.85	24	—	—	—	—	—	—
Ae	0-8	L	43	35	22	5.3	0.1	—	—	—	2.0	0.15	13	13.3	4.6	2.0	0.6	3.1	3.2
ABgj	8-13	CL	31	35	33	5.3	0.2	—	—	—	1.1	0.09	12	15.9	6.0	3.3	0.7	1.0	2.7
Btgj	13-30	C	8	32	61	5.3	0.1	—	—	—	00.7	0.07	10	34.4	15.4	10.8	0.4	2.2	2.8
BCgj	30-41	C	5	31	64	5.8	0.2	—	—	—	00.6	—	—	31.3	14.7	10.7	1.3	1.0	1.6
Ckg	41-51	SiC	10	49	40	7.6	0.3	35..0	9.2	23.7	—	—	—	—	—	—	—	—	—
Ckg2	51 +	SiC	7	48	45	7.5	0.3	18..0	3.9	22.2	—	—	—	—	—	—	—	—	—

less strongly degraded Davis Point soils of the High Boreal-temperate climatic zone also found in this map area.

Mapping Unit

The Warpath series occurs in a number of locations within the map area, often in association with soils of the Chitek, Askandigau, peaty phase, and Cedar Lake series. Warpath soils comprise a total area of 12 812 hectares, which is 1.00 percent of the total map area.

Waskwei Complex (Wsx)

The Waskwei series consists of poorly to very poorly drained deep (>160 cm) organic soils developed on mesic forest peat capped with a thin layer (0 to 65 cm) of fibric Sphagnum moss peat. The underlying mineral sediments are undifferentiated, but usually consist of strongly gleyed, moderately to strongly calcareous, loamy to clayey lacustrine sediments. These soils generally exhibit a flat bog or blanket bog landform, with depressional to level topography. Vegetation is mainly black spruce, with an understory of Sphagnum moss and ericaceous shrubs.

The Waskwei series, a Typic Mesisol, sphagnic phase, is the dominant member of the complex. This series has a 15 to 65 cm surface layer of strongly acid, fibric Sphagnum moss. The Baynham series, a Typic Mesisol with less than 15 cm of Sphagnum peat at the surface, is the subdominant member of the complex.

Soils of the Baynham complex are similar, but have little or no fibric Sphagnum peat overlying the mesic forest peat. A representative profile of the Waskwei complex is given below.

Of1 -	0-55 cm, strong brown (7.5YR 5/6 wet) dominantly fibric Sphagnum; medium to fine fibered; low wood; strongly acid; unrubbed fiber content approximately 92%; rubbing to 80%; clear wavy boundary.
Om1 -	55-110 cm, very dark gray (5YR 3/1 wet moderately decomposed herbaceous forest peat; medium to fine fibered; low wood; neutral; unrubbed fiber content approximately 74%; rubbing to 44%.
Om2 -	110-165 cm, black (5YR 2/1 wet) moderately decomposed herbaceous forest peat, medium to fine fibered, low wood; slightly acid; unrubbed fiber content approximately 72%; rubbing to 32%; clear smooth boundary.
IICkg -	165+ cm, greenish gray (5GY 6/1 moist) silt loam; massive; sticky wet; mildly alkaline; extremely calcareous.

Waskwei soils occur in relatively few map units, most notably on The Pas Moraine, where they often occur in association with other deep organic soils of the Baynham complex and the Stead series.

Mapping Unit

Waskwei soils occupy a total of 6 565 hectares, or 0.51 percent of the map area.

Westray Series (Wy)

The Westray series consists of well to moderately well drained, Orthic Gray Luvisol soils developed on extremely calcareous glacial till. Surface textures range from sandy loam to clay. This wide range of texture is due to the inclusion in the series of soils developed on a very thin (less than 15 cm) lacustrine mantle over the glacial till. These soils occupy the higher till ridges. The topography is gently undulating to undulating, commonly in the form of broad low ridges. Surface runoff is moderate, permeability is medium. These soils are very to exceedingly stony.

The native vegetation is mainly aspen and white spruce with minor occurrences of jack pine, balsam poplar, and willow. A representative profile of the Westray series is described below.

L-H -	4-0 cm, very dark gray (10YR 3/1 moist), leaf and grass mat, slightly acid, abrupt smooth boundary.
Ae -	0-5 cm, light gray (10YR 7/1 moist), loam; moderate, fine platy; friable when moist; slightly acid; abrupt smooth boundary.
Bt -	5-18 cm, brown to dark brown (10YR 4/3 moist), clay; moderate, fine subangular blocky; firm when moist; medium acid; clear wavy boundary.
Ck1 -	18-64 cm, very pale brown (10YR 7/3 moist), loam; weak fine to medium platy; very friable moist; moderately alkaline; extremely calcareous.
Ck2 -	64 cm+, very pale brown (10YR 7/3 moist) silt loam; weak fine to medium platy; very friable moist; moderately alkaline; extremely calcareous.

The Westray soils have the typical Orthic Gray Luvisol profile characteristics, but the horizons are very thin. The entire solum is normally less than 25 cm thick from the surface. On virgin sites a thin, neutral to slightly acid L-H horizon overlies a 2.5 to 5 cm thick light gray Ae horizon that is medium acid in reaction. The thin Bt horizon is fairly well developed and it consists of 5 to 10 cm of brown to dark brown, subangular blocky structured aggregates. The C horizon is extremely calcareous and highly dolomitic.

TABLE 49.
Analysis of Waskwei Series

						Fiber Content								Exch. Cap.	Extractable Cations m.e./100 gm soil						
Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Unrubbed %	Rubbed %	pH 1N KCL	Cond. mmhos/cm	CaCO$_3$ Equiv. %	Org. C %	Total N %	C/N Ratio	m.e./100 gm soil	Ca	Mg	K	Na	H	Pyrophosphate Sol. %	Ash %
Of1	0-55	–	–	–	–	92	80	5.1	–	–	56.8	0.6	94.7	162.8	75.9	42.7	0.6	0.2	43.4	9.0	4.9
Om1	55-110	–	–	–	–	74	44	6.8	–	–	56.3	1.5	37.5	178.6	116.3	40.7	0.2	0.2	21.2	36.0	9.9
Om2	110-165	–	–	–	–	72	32	6.3	–	–	56.7	1.8	31.5	176.3	106.3	37.8	0.1	0.2	31.9	41.0	9.5
IICkg	165 +	SiL	22	52	26	–	–	7.7	0.6	54.2	–	–	–	–	–	–	–	–	–	–	–

TABLE 50.
Analysis of Westray Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	pH 0.01M $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Extractable Cations m.e./100 gm soil Ca	Mg	K	Na	H
L-H	4-0	–	–	–	–	6.2	–	–	–	–	28.8	1.0	28.8	102.8	53.5	25.5	0.5	tr	23.5
Ae	0-5	L	43	46	11	6.0	0.2	–	–	–	1.40	.1	14.0	12.4	5.5	2.7	.2	tr	4.0
Bt	5-18	C	18	37	45	6.9	0.2	–	–	–	1.8	.1	18.0	36.8	22.0	12.2	.5	.1	2.0
Ck1	18-64	L	40	47	15	8.0	0.2	74.2	27.6	42.9	–	–	–	–	–	–	–	–	–
Ck2	64 +	SiL	37	53	10	8.0	0.2	73.6	26.1	43.8	–	–	–	–	–	–	–	–	–

Westray soils of the Low Boreal climatic zone are similar in parent material and drainage to the Garson soils of the High Boreal-temperate climatic zone.

Mapping Unit

The Westray series was mapped only around the town of The Pas, and in association with the Chitek series. The Westray soils comprise a total of 1 073 hectares, which is 0.08 percent of the map sheet.

Whithorn Complex (Whx)

The Whithorn complex consists of deep (>160 cm) organic soils composed of strongly acidic, fibric Sphagnum peat more than 65 cm thick overlying mesic forest or fen peat. The underlying mineral sediments are undifferentiated, but are usually strongly gleyed, moderately to strongly calcareous, loamy to clayey lacustrine sediments. These soils exhibit a raised landform due to the rapid growth of Sphagnum mosses. The topography of these soils is level to gently sloping, and drainage is poor to very poor . Water samples from these areas are very ombotrophic (nutrient deficient) as the site is above the regional water table and moisture is provided mainly by precipitation. Native vegetation on Whithorn soils is stunted black spruce, Labrador tea, leather leaf, and Sphagnum moss.

The dominant member of the complex is the Whithorn series, a Mesic Fibrisol with a surface layer of 80 to 135 cm of fibric Sphagnum moss peat. The Julius series, a Typic Fibrisol with greater than 125 cm of fibric Sphagnum peat, and the Santon series, a Fibric Mesisol with 65 to 80 cm of fibric Sphagnum surface peat, are the subdominant members of the complex.

Soils of the Whithorn complex are similar to those of the Julius series, differing only in that Whithorn soils have a slightly thinner layer of fibric Sphagnum peat at the surface. A representative profile of the Whithorn series is given below.

Of1 - 0-50 cm, dark reddish brown (5YR 3/3 broken) pinkish gray (7.5YR 7/2 pressed) pink (7.5YR 7/4 rubbed) fibric Sphagnum moss; medium to fine fibered; non-woody; extremely acid; unrubbed fiber approximately 86%; rubbing to 64%.

Of2 - 50-110 cm, very dark brown (10YR 2/2 broken) light gray (10YR 7/2 pressed) pale brown (10YR 6/3 rubbed) fibric Sphagnum moss; medium to fine fibered; non-woody; extremely acid; unrubbed fiber approximately 84%; rubbing to 66%; clear wavy boundary.

Om1 - 110-175 cm, black (10YR 2/1 broken) dark grayish brown (10YR 4/2 pressed) dark brown (10YR 3/3 rubbed) moderately decomposed forest peat, dominantly fine fibered with odd coarse wood fragments; low wood; extremely acid; unrubbed fiber approximately 60%; rubbing to 32%; clear smooth boundary.

IICkg - 175+ cm, gray (5Y 5/1 moist) clay; massive; very sticky wet; mildly alkaline; moderately calcareous.

Mapping Unit

Whithorn soils occur in the south west quarter of the map sheet, covering an area of 18 470 hectares, or 1.44 percent of the map area.

TABLE 51.
Analysis of Whithorn Series

Hor.	Depth cm	Text.	Sand %	Silt %	Clay %	Fiber Content Unrubbed %	Fiber Content Rubbed %	pH 1N KCL	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 gm soil	Ca	Extractable Cations m.e./100 gm soil Mg	K	Na	H	Pyrophosphate Sol. %	Ash %
Of1	0-50	–	–	–	–	86	64	2.7	–	–	59.5	0.5	114.4	127.5	10.0	3.9	0.2	0.5	112.9	8.0	2.08
Of2	50-100	–	–	–	–	84	66	3.1	–	–	59.8	0.6	97.9	121.2	18.5	5.8	0.2	0.5	96.4	14.1	3.15
Om3	100-175	–	–	–	–	66	52	4.5	–	–	56.3	0.9	64.7	127.8	62.8	14.8	0.3	0.8	50.1	27.0	9.25
IICkg	175 +	C	3	30	67	–	–	7.6	–	15.6	–	–	–	–	–	–	–	–	–	–	–

PART 4

INTERPRETATIONS OF SOILS MAPPED IN THE PAS AREA

INTRODUCTION

Seventy-nine types of soil have been recognized and mapped in The Pas map area. Each of them has a unique combination of profile characteristics, texture, moisture retention, consistence, mineralogical and chemical composition, and each of them is found in a unique landscape setting as determined by climate, vegetation, topography, slope and moisture regime. All of them, to a varying degree, have different management requirements, use capabilities and yield potential. Some soils have certain similarities by which they can be grouped together to serve a particular purpose. As a general rule, special groupings or interpretive classifications are based on a small number of characteristics known to be relevant to the purpose at hand. These groupings are often made employing some associated external quality or characteristic of the soil, for example, crop yield data can be treated as an external soil quality to determine soil suitability for agriculture. When such evaluations and interpretations are based on data accumulated during the soil survey and upon related applied research and experience gained in managing land, they yield a better soil-to-specific use correlation. They are, in other words more useful to non-soil surveyors than the more comprehensive, more broadly applied general data contained in soil maps and reports.

The interpretive information provided in this section is based on evaluations of internal and external soil characteristics and on predictions of soil behaviour under specified conditions of land use and management. All interpretations are derived from soil ratings based on the properties and characteristics of each soil. Each soil has been described in an earlier section of the report, and identified and delineated on the map. In many instances, the interpretive ratings are based on site specific data. Therefore, discretion, with an understanding of the limitations of the soil map must be exercised when extrapolating interpretive soil ratings to the soil units delineated on the map. The predictive value of the soil maps depends largely on the scale of mapping and homogeneity of the soils delineated within the map unit. The predictive value and reliability of interpretations is usually much higher for soils delineated in portions of the map area where access is good enabling more intense groundtruth.

The map units themselves are not defined in the map legend or in the report. The actual meaning and composition of individual map units must be derived from the map symbol by referring to the descriptive legend attached to the map and by referring to the relevant descriptive and interpretive sections within the report.

The map symbols identify land units in terms of the dominant and significant soils which occur in the unit. Areas of extreme variation in texture, drainage or topography within short distances have complex map symbols showing different combinations and proportions of soil series. More uniform soil areas with less variability over short distances are characterized by map units which consist primarily of a single soil series or phase of soil series. The reader is referred to the Section on Soil Mapping Units, for a more complete description of how soil variability is mapped and described by means of single and compound map units.

Regardless of the limitations imposed by scale, the map serves as a bridge to identify properties of soils important to plant growth and to engineering uses. The map also provides a geographical frame-work for organizing and extending available knowledge about soils to specific locations. New discoveries and relationships derived from research and in-the-field testing can be extended to other areas of similar soils.

Kinds of Soil Interpretations

In this section, interpretive soil information is provided in tabular form for the following land use evaluations:

1. Agriculture: a) dryland farming capability (b) irrigation suitability

2. Forestry

3. Engineering

4. Recreation

These interpretations are not intended as a guide to the most profitable use of land nor do they eliminate the need for on-site evaluations by qualified professionals. The need for, or importance of on-site studies depends on the use to be made of the soil, the kinds of soil and the soil problems involved. The interpretations and evaluations presented here are intended primarily as a guide to better land use.

AGRICULTURE

Soil Capability for Dryland Agriculture

A summary of the soils showing their major characteristics and their interpretive classifications for both dryland and irrigated agriculture is presented in Table 52. The criteria and methodology used for the classification of soil capability for dryland farming and soil suitability for irrigation are described in the following sections.

In this classification the mineral soils are grouped into seven classes on the basis of their limitations for dryland farming. The first three classes are considered capable of sustained production of common field crops, the fourth class is marginal for sustained arable agriculture, the fifth class is capable of use only for improved permanent pasture, the sixth class is capable of use only for wild pasture, while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture. While the soil areas in classes one to four are capable of use for cultivated field crops, they are also capable for use as permanent pasture. Soils in all classes may be suitable for forestry, wildlife and recreational uses. For purposes of this classification, trees, shrubs and ornamental plants that require little cultivation are not considered.

This soil capability classification is based on the assumption that:

1. It is an interpretive classification based on the effects of combinations of climate and soil characteristics and their general productive capacity for common field crops.

2. Soils will be well managed and cropped, using a largely mechanized system of culture.

3. Soils within a capability class are similar with respect to degree but not kind of limitation. Each class includes many different kinds of soils and many soils within any one class require unlike management.

4. Soils considered economically feasible for improvement by drainage, by irrigating, by removing stones, by altering soil structure, or by protecting from overflow (flooding) are classified according to their continuing limitations or hazards after improvements have been made.

5. The capability classification of the soils in an area may be changed when major reclamation works are installed that permanently change the limitations in use for agriculture. This would apply in the case of soils having very severe limitations of Class 6, (e) erosion, (i) inundation, and (w) excessive wetness.

6. Distance to market, kind or roads, location, size of farms, characteristics of land-ownership, cultural patterns and the skill or resources of individual operators are not criteria for capability groupings.

7. Capability groupings are subject to change as new information about the behavior and responses of the soils become available.

The capability classification consists of three categories: class, subclass, and unit.

1. The *capability class*, the broadest category, is a grouping of soils that have the same relative degree of limitation or hazard for agriculutral use. The limitation becomes progressively more severe from Class 1 to Class 7. The 7 capability classes are:

   Class 1: Soils which have no significant limitations in use for crops.
   Class 2: Soils which have moderate limitations that restrict the range of crops or require moderate conservation practices.
   Class 3: Soils which have moderately severe limitations that restrict the range of crops or require special conservation practices.
   Class 4: Soils which have severe limitations that restrict the range of crops or require special conservation practices, or both.
   Class 5: Soils which have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible.
   Class 6: Soils which are capable of producing perennial forage crops, and improvement practices are not feasible.
   Class 7: Soils which have no capability for arable culture or permanent pasture.

2. The *capability subclass* is a grouping of soils with similar kinds of limitations and hazards. The subclass limitations for soils in the The Pas area are defined below.

   Subclass D Designates soils with undesirable soil structure and/or low permeability. It is used for soils where the depth of rooting zone is restricted by soil conditions other than wetness (high water table) or consolidated bedrock.
   Subclass E Designates soils where actual damage from erosion is a limita-

TABLE 52

Summary of Soils Showing Their Major Characteristics and Their Interpreted Classification for Agriculture

Soil Symbol	Soil Name	Surface Texture	Phase	Drainage	Subgroup	Total Extent (hectares)	Land Class*	
							Dryland Capability	Irrigation Suitability
As	Askandigau	Clay	—	Poor	Rego Gleysol	3 089	6W2-4WD	4D1
As(P)	Askandigau	Clay	Peaty	Poor	Rego Gleysol	8 627	6W2-4WD	4D1
At	Atikameg	Loam to clay loam		Well	Eluviated Eutric Brunisol	17 925	4P1	4Sr
B	Big Lake	Loam to clay loam	Carbonated	Poor	Rego Gleysol	16 297	6W1-3W	4D1
B(d)	Big Lake	Loam to clay loam	Carbonated Drained	Poor	Rego Gleysol	410	3W	4D1
B(P)	Big Lake	Loam to clay loam	Carbonated Peaty	Poor	Rego Gleysol	22 637	6W1-3W	4D1
Bc	Birch Bay	Loam to clay loam		Imperfect	Gleyed Eluviated Eutric Brunisol	1 792	6RP	4SrD
Be(d)	Big Eddy	Clay	Carbonated Drained	Poor	Rego Gleysol	571	3W	4D1
C	Carrot	Loam to clay loam		Imperfect	Gleyed Cumulic Regosol	10 810	2X	1
Ca	Cayer	Organic		Very poor	Terric Mesisol	107 768	04W-1	4D2
Chx	Chocolate Complex	Organic		Very poor	Terric Mesisol, Terric Fibric Mesisol, Terric Fibrisol	1 015	06WF-2	4D2
Ci	Chitek	Loam to clay loam		Imperfect	Gleyed Eluviated Eutric Brunisol	48 425	4P2	4SrD
Cl	Cedar Lake	Clay		Well	Orthic Gray Luvisol	16 971	3D	4Sh
Cp	Catfish Point	Organic		Very poor	Terric Mesic Fibrisol	1 210	06WF-2	4D2
cR	Carbonate Bedrock	Bedrock		Rapid		5 430	7R	4Sbr
Cr	Crane	Organic		Very poor	Terric Mesisol	15 246	05WD-1	4D2
Dp	Davis Point	Clay		Imperfect	Gleyed Dark Gray	6 380	2W1	4ShD
Dr	Dering	Loam to clay loam	Carbonated	Poor	Rego Gleysol	17 044	6WP-5WP	4DSr
Dr(P)	Dering	Loam to clay loam	Carbonated Peaty	Poor	Rego Gleysol	43 381	6WP-5WP	4DSr
Dv	Duck River	Loam		Imperfect	Gleyed Dark Gray	2 886	2W2	2D
Ea(P)	Easterville	Coarse sand and gravel	Carbonated Peaty	Poor	Rego Gleysol	1 296	6WP	4D1
Ei	Egg Island	Clay	Shallow lithic	Well	Orthic Gray Luvisol	994	5PR	4Sh
Fd	Fairford	Loam to clay loam		Well	Eluviated Eutric Brunisol	1 497	4P1	4Sr
Fo	Foley	Loam	Carbonated	Poor	Rego Humic Gleysol	521	6W1-3W	4D1
Fo(P)	Foley	Loam	Carbonated Peaty	Poor	Rego Humic Gleysol	768	6W1-3W	4D1
Fx	Freshford Complex	Coarse sand and gravel		Well	Eluviated Eutric Brunisol	4 498	5M1	4Svq
Gdx	Grindstone Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase, Terric Fibric Mesisol	8 277	06WD-2	4D2
Ghx	Guy Hill Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase, Terric Fibric Mesisol	3 476	04WL-2	4D2
Hb	Homebrook	Clay		Well	Orthic Dark Gray	2 863	2D	4Sh
Hl	Halcrow	Organic		Very poor	Terric Mesisol sphagnic phase	5 907	06WD-2	4D2
Ho	Homestead	Loam to clay loam		Imperfect	Gleyed Cumulic Regosol	1 103	2X	1
Hrx	Horseshoe Island Complex	Coarse sand and gravel		Imperfect	Gleyed Eluviated Eutric Brunisol, Gleyed Gray Luvisol	3 544	4M2	4SvD
Hw	Howell	Organic		Very poor	Terric Mesisol, sphagnic phase	9 756	04W-1	4D2
In	Inwood	Loam to clay loam		Imperfect	Gleyed Gray Luvisol	281	4P2	4SrD
Kc	Kircro	Organic		Very poor	Terric Mesisol	15 515	04W-1	4D2
Ki	Kinwow	Clay		Well	Orthic Gray Luvisol	1 395	3D	4Sh
Ko	Koostatak	Clay		Poor	Rego Humic Gleysol	1 528	6W1-3W	4D1
Ko(P)	Koostatak	Clay	Peaty	Poor	Rego Humic Gleysol	3 088	6W1-3W	4D1
Kt	Katimik	Organic		Very poor	Typic Mesisol, sphagnic phase	16 475	04W	4D2

TABLE 52 (Continued)

							Land Class*	
Soil Symbol	Soil Name	Surface Texture	Phase	Drainage	Subgroup	Total Extent (hectares)	Dryland Capability	Irrigation Suitability
Kx	Kilkenny Complex	Organic		Very poor	Terric Mesic Fibrisol, Terric Fibric Mesisol, Terric Fibrisol	10 686	06WD-2	4D2
Li	Limestone Point	Loam to clay loam	Shallow and very shallow lithic	Well	Eluviated Eutric Brunisol	20 422	6RP	4Sbr
Li(s)	Limestone Point	Loam to clay loam	Extremely shallow lithic	Well	Eluviated Eutric Brunisol	14 286	7R	4Sbr
Llx	Lamb Lake Complex	Organic		Very poor	Terric Mesisol sphagnic phase, Terric Mesisol, Terric Fibric Mesisol, Terric Mesic Fibrisol	35 422	06WD-2	4D2
Lp	Le Pas	Clay	Carbonated	Poor	Rego Gleysol	8 909	6WD-3WD	4D1
Lt	Lettonia	Clay		Well	Solonetzic Gray Luvisol	158	3D	4Sh
Mg	Mantagao	Clay		Imperfect	Gleyed Gray Luvisol	4 893	3DW	4ShD
Mh	Marsh			Very poor	Rego Gleysol	15 931	7W	4D1
Ml	Meleb	Loam to clay loam	Carbonated	Poor	Rego Humic Gleysol	275	5WP	4DSr
Ml(P)	Meleb	Loam to clay loam	Carbonated Peaty	Poor	Rego Humic Gleysol	8 713	5WP	4DSr
Mu	Mukatawa	Clay		Imperfect	Gleyed Solonetzic Gray Luvisol	546	3DW	4ShD
Mx	Molson Complex	Organic		Very poor	Terric Mesic Fibrisol, Terric Fibric Mesisol, Terric Fibrisol	51 560	06WF-2	4D2
N	Nels	Fine sandy loam to loam		Imperfect	Gleyed Cumulic Regosol	19 364	2X	1
Nb(P)	Napanee Bay	Clay	Peaty	Poor	Rego Humic Gleysol	356	6W2-4WD	4D1
Nlx	Nekik Lake Complex	Organic		Very poor	Mesic Organic Cryosol, Fibric Organic Cryosol	913	06WF-2	4D2
No	Novra	Loam to clay loam		Poor	Rego Gleysol	1 276	6W1-3W	4D1
No(P)	Norris	Coarse sand to gravel	Carbonated	Poor	Rego Gleysol	1 874	6W1-3W	4D1
Nr	Novra	Loam to clay loam	Peaty	Poor	Rego Gleysol	3 161	6W2-4W	4D1
Nr(P)	Norris	Coarse sand to gravel	Carbonated Peaty	Poor	Rego Gleysol	7 622	6W2-4W	4D1
Orx	Orok Complex	Organic		Very poor	Terric Mesisol sphagnic phase, Terric Mesisol, Terric Fibric Mesisol, Terric Mesic Fibrisol	12 059	04WL-2	4D2
Ox	Okno Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase, Terric Fibric Mesisol	10 001	04WL-2	4D2
Ov	Overflowing	Organic		Very poor	Typic Mesisol aquic phase	11 597	07W-3	4D2
P	Pasquia	Fine sandy loam to loam	Carbonated	Poor	Rego Gleysol	6 075	6W1-3W	4D1
P(d)	Pasquia	Fine sandy loam to loam	Carbonated Drained	Poor	Rego Gleysol	1 052	3W	4D1
P(P)	Pasquia	Fine sandy loam to loam	Carbonated Peaty	Poor	Rego Gleysol	7 839	6W1-3W	4D1
Rex	Reed Lake Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase	669	06W-2	4D2
RIx	Rock Island	Organic		Very poor	Typic Mesisol, Typic Mesisol sphagnic phase	1 115	06W-2	4D2
Rrx	Rat River Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase, Terric Fibric Mesisol	8 096	04WL-2	4D2
Sb	Sand beaches	Sand		Well to Imperfect	Regosol	265	7M	4Svq
Sd	Stead	Organic		Very poor	Typic Mesisol	34 625	04W-2	4D2
Sf	Swanford	Loam		Imperfect	Gleyed Rego Black	521	2W2	2D
Sfx	Saline flats		Saline	Poor	Rego Gleysol	350	7WN	4DSa
Sm(P)	Sagemace	Clay	Peaty	Poor	Rego Humic Gleysol	5 441	6W2-4WD	4D1
Sox	Soul Lake Complex	Coarse sand and gravel		Well	Eluviated Eutric Brunisol, Orthic Gray Luvisol, Orthic Eutric Brunisol	1 956	4M1	4Svq

TABLE 52 (Continued)

Soil Symbol	Soil Name	Surface Texture	Phase	Drainage	Subgroup	Total Extent (hectares)	Land Class* Dryland Capability	Land Class* Irrigation Suitability
Srx	Sand River	Organic		Very poor	Terric Mesic Fibrisol, Terric Fibric Mesisol, Terric Fibrisol	11 387	06WF-2	4D2
Tux	Tremauden Complex	Coarse sand and gravel		Imperfect	Gleyed Eluviated Eutric Brunisol, Gleyed Gray Luvisol	2 695	5M2	4SvD
Whx	Whithorn Complex	Organic		Very poor	Mesic Fibrisol, Typic Fibrisol, Fibric Mesisol	18 470	06WF-2	4D2
Wr	Warpath	Clay		Imperfect	Gleyed Gray Luvisol	12 812	3DW	4ShD
Wsx	Waskwei Complex	Organic		Very poor	Typic Mesisol, sphagnic phase, Typic Mesisol	6 565	04WL-2	4D2
Wy	Westray	Loam to clay loam		Well	Orthic Gray Luvisol	1 073	5P	4Sr

* Capability class of mineral soils is indicated by a numeral, subclass limitation by alphabetic symbol and capability unit by numeral subscript. In some cases some of the mineral soils also show a potential capability eg. (Big Lake (B), 6W-3W). The second capability rating is the potential, that is the capability resulting from a large scale reclamation (eg. government sponsored drainage of Pasquia Land Settlement).
Capability classification of organic soils are preceeded by "0" and followed by a – numeral indicating the relative degree of development difficulty.

	tion to agricultural use. Both wind and water erosion are recognized. Damage is assessed on probable loss in productivity due to the loss of topsoil and/or the difficulties imposed by gullies cut into the fields which makes farming the affected soil areas more expensive.
Subclass I	Designates soils which are subjected to inundation by streams or lakes. The class is dependent upon frequency and duration of inundation.
Subclass M	Designates soils with moisture limitations. These soils are adversely affected by droughtiness owing to coarse soil texture and low water holding capacity. (Droughtiness caused by inherent soil characteristics is not to be confused with climatic drought).
Subclass N	Designates soils which are adversely affected by the presence of soluble salts.
Subclass P	Designates units of soils sufficiently stony to significantly hinder tillage, planting and harvesting operations.
Subclass R	Designates soils where the depth of the rooting zone is restricted by consolidated bedrock, e.g. less than 30 cm of soil over rock would be class 5R.
Subclass S	Designates soils with more than 2 limiting characteristics such as D,M, and N.
Subclass T	Designates soils which have topographic (slope and pattern) limitations for agricultural use.
Subclass W	Is assigned to soils where excess water, other than that brought about by inundation, is a limitation in their use for agriculture. Excess water may be the result of poor soil drainage, high water table, seepage, or runoff from surrounding areas. Usually, soils needing drainage have a continuing limitation that precludes placing them in Class 1 even after drainage.

3. The *capability unit* is a subdivision within the subclass category that groups together soils that will respond similarly to a given management input.

Application of the Soil Capability Ratings to Map Units

Map units represent segments of land. They are described by named soil series either in single map units or in compound map units. Descriptions of the units are modified by identifying topographic, erosion and stoniness phases of series as well. The same number and kind of soil series may occur in many different map units which have been delineated on the basis of variations in characteristics such as configuration of the land surface. For example, if topography or degree of stoniness is the significant difference between two otherwise similar map units, then the change in capability is a reflection of the change in the degree of difficulty of management as a result of these differences.

The actual productive capability of the soil remains relatively unchanged. If, however,salinity is the major difference between two otherwise similar map units, then the change in capability is primarily a reflection of the change in fertility and, therefore, the productive capacity of the map unit. Each of these limitations will necessitate implementation of a different management program for efficient agricultural use of these soils. Each soil series mapped in the The Pas area has been given an initial capability rating (see Table 52) based on its inherent properties and its associated normal or typical conditions of topography, erosion and stoniness.

Capability of Mineral Soils in The Pas Area for Dryland Agriculture

The climate in the The Pas area is suitable for a wide variety of cereal and forage crops under dryland farming conditions. Precipitation and temperature during the growing season are favorable and pose only slight limitations to crop growth (refer to climatic section).

Class 1

Soils in this class have no significant limitations that restrict their use for crops. These soils have level or gently sloping topography, are deep, well to imperfectly drained and have moderate water holding capacity. They are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility and moderately high to high in productivity for a wide range of field and vegetable crops. No soils in The Pas area are listed in this capability class

Class 2

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. These soils usually have a good waterholding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderately high to high in productivity for a fairly wide range of crops. Good soil management and cropping practices can be applied without difficulty.

2X These are imperfectly drained, coarse loamy to fine loamy, level to gently sloping alluvial soils. There is a cumulative effect of slight drainage and climatic problems which put these soil in Class 2X. The soils are:

		Extent (ha)	*% of Map Area*
C	Carrot	10 810	.85
Ho	Homestead	1 103	.09
N	Nels	19 364	1.51
	Total	31 277	2.45

2D The well drained soil in this subclass is developed on slightly stony, slightly undulating to undulating clayey till. The main soil problem is maintenance of tilth and good aeration. If cultivated when too moist or too dry large massive lumps will result forming a poor seed bed. The soil in this subclass is:

		Extent (ha)	*% of Map Area*
Hb	Homebrook	2 863	.22

2W1 The soil found in this subclass is on an imperfectly drained, slightly undulating to undulating, slightly stony, clayey till site. This soil does have structure problems, in that if it is worked when too moist or too dry, massive lumps will result, leaving a poor seedbed. Since these soils are affected by excess wetness after shallow surface drains should be constructed to remove standing surface water. The soil in this subclass is:

		Extent (ha)	*% of Map Area*
Dp	Davis Point	6 380	.50

2W2 The soils found in this subclass are developed on imperfectly, drained, level to gently sloping, loamy lacustrine sites. These soils may have internal drainage problems in spring and after heavy rains. Incorporation of trash stubble will help these soils maintain good tilth, and structure and permeability.. These soils are:

		Extent (ha)	*% of Map Area*
Dv	Duck River	2 886	.23
Sf	Swanford	521	.04
	Total	3 407	.27
	Total Class 2	43 927 ha	3.44

Class 3

Soils in this class have moderately severe limitations that reduce the choice of crops or require special management and conservation practices. In this class, limitations that affect or restrict cultivation, ease of tillage, the timing of planting and harvesting, the choice of crops or the application and maintenance of conservation practices or a combination of two of these described for class 2 or one of the following; moderate climatic limitation, including frost pockets, structure or very slow permeability; low fertility correctable with consistent heavy applications of fertilizers and usually lime; moderate to strong slopes; poor drainage; low water holding capacity; stoniness. The subclasses and units in this class are:

3D These well drained clayey soils are slightly stony. They occur in a region which has a moderate climate limitation (2c). Adverse structure provides enough interference to cultivation to lower subclass rating from 2c.

		Extent (ha)	% of Map Area
Cl	Cedar Lake	16 971	1.33
Ki	Kinwow	1 395	.11
Lt	Lettonia	158	.01
	Total	18 524	1.45

3DW These imperfectly drained clayey lacustrine soils have a moderate climatic limitation. These soils have internal drainage problems in spring after snow melt and after heavy summer rains. Shallow surface drains should be constructed to remove standing surface water. Undesireable soil structure (coarse to very coarse cloddy condition) when these soils are cultivated too moist or too dry. The soils found in this class are:

		Extent (ha)	% of Map Area
Mg	Mantagao	4 893	.38
Mu	Mukatawa	546	.04
Wr	Warpath	12 812	1.00
	Total	18 251	1.42

3W These poorly drained loamy soils are nonarable (Class 6W) in their natural state, but adequate surface drainage has been provided. Where adequate drainage has been provided these soils are still be subject to a moderately severe limitation of wetness.

		Extent (ha)	% of Map Area
B(d)	Big Lake (drained)	410	.03
Be(d)	Big Eddy, (drained)	571	.04
P(d)	Pasquia (drained)	1 052	.08
	Total	2 033	.15
	Total Class 3	38 808	3.02

Class 4

The soils in this class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops, or the yield for a range of crops may be low or risk of crop failure is high. The limitations may seriously affect such farming practices as the timing and ease of tillage, planting and harvesting, that often results in reduced yields.

4P1 These well and moderately well drained soils are very stony. The soils are dominantly loamy tills and occupy level to undulating topography. Stone picking is required to improve these soils so that common tillage practises are not hindered. The soils are:

		Extent (ha)	% of Map Area
At	Atikameg	17 925	1.40
Fd	Fairford	1 497	.12
	Total	19 422	1.52

4P2 These are imperfectly drained loamy till soils occuring in level to gently undulating topography. These soils are very stony and require stone removal for continuous cultivation. The soils are:

		Extent (ha)	% of Map Area
Ci	Chitek	48 425	3.79
In	Inwood	281	.02
	Total	48 706	3.81

4M1 These are well to rapidly drained sandy to gravelly soils characterized by low water holding capacity. The occurence of less permeable loamy till within a meter of the surface helps to offset the natural droughtiness of these soils. They are usually low in organic matter and natural fertility. Some stones may be present on those soils underlain at shallow depths by till. The soil in the subclass is:

		Extent (ha)	% of Map Area
Sox	Soul Lake	1 936	.15

4M2 These are imperfectly drained sandy to gravelly soils characterized by low water holding capacity. The occurence of less permeable loamy till within the surface meter helps offset the sometimes droughtiness of these soils. They are usually low in organic matter and natural fertility. Some stones may be present on those soils underlain at shallow depths by till. The soil in this subclass is:

		Extent (ha)	% of Map Area
Hrx	Horseshoe Island	3 544	.27
	Total Class 4	73 608	5.75

Class 5

Soils in this class have very severe limitations that restrict their capability to produce perennial forage crops, but improvement practices are feasible. These soils have such serious, soil, climatic or other limitations that they are not capable of use for sustained production of annual cereal crops. However they may be improved by use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practises include clearing of bush, cultivation, seeding, fertilizing and water control. The limitations include adverse effects of one or more of the following; severe climate, low water holding capacity, severe past erosion, steep slopes, very poor drainage, very frequent overflow, severe salinity permitting only salt tolerant forage crops to grow, stoniness or shallowness to bedrock that make annual cultivation impractical. The capability units in this class are:

5M1 These are well to rapidly drained sandy to gravelly soils characterized by low water holding capacity. Due to the rapid runoff and their low water holding capacity these soils are moderately severely affected by droughtiness. The soils are:

		Extent (ha)	*% of Map Area*
Fx	Freshford	4 498	.35

5M2 These are imperfectly drained sandy to gravelly soils characterized by low water holding capacity. Due to low water holding capacity these soils are moderately affected by droughtiness. The soils are:

		Extent (ha)	*% of Map Area*
Tux	Tremauden	2 694	.21

5WP These are poorly drained loamy soils occuring in level to depressional areas and are normally saturated with water for a considerable portion of the growing season. They are moderately to excessively stony, and if adequate surface drainage is provided they will still be subject to a continuing severe stoniness limitation. Some of the soils have a thin surface layer of peat which covers some of the surface stones. The soils are:

		Extent (ha)	*% of Map Area*
Ml	Meleb	275	.02
Ml(P)	Meleb, peaty phase	8 713	.68
	Total	8 988	.70

5P These well drained, loamy textured, water-worked till soils, are very stony. In more severely water, waterworked areas they are excessively stony. The soils in this class are:

		Extent (ha)	*% of Map Area*
Wy	Westray	1 073	.08

5PR These are moderately well drained clayey soils developed on thin clayey sediments overlying stony loamy till which in turn overlies limestone bedrock. Both the clay surface and bedrock impede root and water penetration. The rather stony condition of the surfaces of these soils imposes an additional limitation to cultivation. The soils are:

		Extent (ha)	*% of Map Area*
Ei	Egg Island	994	.03
	Total Class 5	18 247	1.37

Class 6

Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for livestock, but have such serious soil, climate, or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents improvement through the use of farm machinery, or the soils are not responsive to improvement practices or because of a short grazing season. Such improvement as may be affected by seeding and fertilizing by hand or by aerial methods shall not change the classification of these soil areas.

The limitations include the adverse effects of one or more of the following; very severe climate, very low water holding capacity, very steep slopes, very severely eroded land, severely saline producing only salt tolerant native plants, very frequent overflow, water on the soil surface for most of the year and stoniness or shallowness to bedrock that make annual cultivation impractical. The capability units in this class are:

6W These poorly to very poorly drained dominantly loamy soils occur in level to depressional areas and are normally saturated with water for the major part of the growing season. Some of these soils have a peaty surface layer. If drainage is provided on a project scale as was done in the Pasquia project these soils would have potential capability of Class 3W.

		Extent (ha)	*% of Map Area*
B	Big Lake	16 297	1.27
B(P)	Big Lake, peaty phase	22 637	1.77
Fo	Foley	521	.04
Fo(P)	Foley, peaty phase	768	.06
Ko	Koostatak	1 528	.12
Ko(P)	Koostatak, peaty phase	3 088	.24
No	Novra	1 276	.7
No(P)	Novra, peaty phase	1 874	.15
P	Pasquia	6 075	.48
P(P)	Pasquia, peaty phase	7 839	.61
	Total	61 903	4.84

6W1 These poorly to very poorly drained dominantly clayey soils occur in level to depressional areas and are normally saturated with water for a considerable portion of the growing season. Some of these soils have a peaty surface layer. In the case of these soils, if adequate drainage is provided, the potential agricultural capability improves to 4WD. Most of these soils have a structure problem if worked when too moist or too dry. The soils are:

		Extent (ha)	*% of Map Area*
As	Askandigau	3 089	.24
As(P)	Askandigau, peaty phase	8 627	.67

Nb(P)	Napanee Bay, peaty phase	356	.03
Nr	Norris	3 161	.25
Nr(P)	Norris, peaty phase	7 622	.60
Sm(P)	Sagemace, peaty phase	5 441	.43
	Total	28 296	2.22

6W2 These poorly to very poorly drained clayey soils occur in level to depressional areas and are normally saturated with water for the major part of the growing season. If drainage is provided on a project scale as was done in the Pasquia project these soils would have a potential capability of Class 3WD. The structure problem would arise from working this land when either too moist or too dry, leaving lumps. The soil is:

		Extent (ha)	*% of Map Area*
Lp	LePas	8 909	.70

6WP These poorly to very poorly drained loamy soils occur in level to depressional areas and are normally saturated with water for a considerable portion of the growing season. They are moderately to excessively stony and if adequate surface drainage is provided they will be subject to a continuing severe stoniness limitation. Some of the soils have a thin surface layer of peat which covers some of the surface stones. These soils are located in a somewhat colder climatic region in the map area. The potential agricultural capability after drainage is Class 5WP. The soils are:

		Extent (ha)	*% of Map Area*
Dr	Dering	17 044	1.33
Dr(P)	Dering, peaty phase	43 381	3.39
Ea(P)	Easterville, peaty phase	1 296	.7
	Total	61 721	4.82

6RP These well and imperfectly drained soils are exceedingly to excessively stony. They are also underlain at 50 to 70 cm by consolidated limestone bedrock so that the rooting zone is restricted. These soils may be somewhat droughty in drier years due to the cobbly nature of the rock rubble material lying between the bedrock and the shallow till mantle. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Bc	Birch Bay	1 792	.14
Li	Limestone Point	20 422	1.60
	Total	22 214	1.74
	Total Class 6	183 043	14.32

Class 7

Soils in this class have no capability for arable culture or permanent pasture. The Class 7 soils have limitations so severe that they are not capable of use for arable culture or permanent pasture. These lands may or may not have a high capability for trees, native fruits, wildlife and recreation. The capability units in this class are:

7M These are well to imperfectly drained, sandy and gravelly areas of gentle sloping beach deposits or narrow, well drained gravelly and cobbly ridges bordering many of the lakes of the area.

		Extent (ha)	*% of Map Area*
Sb	Sand Beaches	265	.07

7R These are areas of numerous rock outcrops and shallow soil (0-25 cm) over bedrock in which there is not enough soil to support an appreciable amount of vegetation.

		Extent (ha)	*% of Map Area*
cR	Carbonate bedrock	5 430	.42
Li(s)	Limestone Point, shallow	14 286	1.12
	Total	19 716	1.54

7W These are very poorly drained level to depressional marshy areas which are covered with water or are saturated for most of the year.

		Extent (ha)	*% of Map Area*
Mh	Marsh	15 931	1.25

7WN These are level to very gently sloping areas in which the concentration of salts is such that the growth of useful native vegetation is impossible. High water table conditions prevent removal of this excessive saline condition.

		Extent (ha)	*% of Map Area*
Sf	Saline Flats	350	.03
	Total Class 7	36 262	2.89

Soil Capability of Organic Soils in the The Pas Map Area for Dryland Agriculture

In Canada, no national system has yet been adopted for classifying organic soils for agricultural capability. The system and approach used in Manitoba is basically a modification of the mineral soil capability classification for agriculture as described in the previous section. The guidelines and criteria used to make such interpretive judgements are patterned after methodology used in

Ontario by Leeson[17], and modified for Manitoba by Mills[18].

Water table control is the main reclamation requirement for the agricultural development of organic soils. Optimum water table control is necessary for successful crop production and for the long-term maintenance of the soil itself. If the water regime is not manipulated correctly, the organic soil base may be lost through increased rates of subsidence, potentially irreversible physical damage to the soil, and increased hazards of wind erosion and fire damage. Even when water control is at optimum levels (with the water table usually 45 to 90 cm below the surface) for both crop production and the slowest rates of subsidence, soil loss through subsidence can continue at rates of 2 to 5 cm annually. The capability ratings therefore take into account the eventual loss of the organic soil base, and reflect the potential for continuing use of such areas based on the character of the underlying mineral materials. Shallow organic soil areas underlain by unsuitable mineral substrates would not be useful as a productive land base and should not be reclaimed for agricultural use.

The evaluation of organic soils for agriculture is carried out in two steps. First, the organic soils are placed in capability classes. This rating indicates the agricultural potential of the soil according to any hazards that would remain after reclamation and that would therefore be a continuing limitation to agricultural production. The second step recognizes that, to be used for agriculture, most organic soils require development from the natural state with various degrees of difficulty and associated economic costs. The relative degree of difficulty in carrying out development is expressed in a development difficulty rating. This rating reflects the properties and qualities of organic soils that significantly influence reclamation. The presence or absence of trees; the content of large wood fragments; the permeability, density, and degree of decomposition of peat; and the natural water table levels all exert a significant influence on the development of peatlands.

Recommendations for the development of organic soils are therefore based on both the development difficulty rating and the continuing capability of soils after reclamation.

The agricultural capability of organic soils is ranked in seven classes, according to the degree of continuing limitation that particular hazards may place on the production of agricultural crops. Class 1 organic soils have few limitations, the widest range of use, and the least risk of damage when they are used for agriculture. The degree of limitation increases from Class 1 to Class 7 and the agricultural potential decreases correspondingly from Class 1 to Class 7.

The first three categories contain soils that are considered capable of sustained production of common field crops; soils in the fourth class are marginally capable of supporting sustained arable culture; the fifth class is capable of use for improvable permanent pasture and hay; the sixth class can be used only for native pasture; and the seventh contains soils and land types considered incapable of use for arable culture or permanent pasture. Although the soils in the first four classes can be used for cultivated crops, it should be noted that they may be equally useful for perennial forage crops or pasture. Soil areas in all classes may be suitable for uses other than agriculture.

The capability classification for organic soils consists of the capability class and the capability subclass. The class rating is a grouping of subclasses that have the same relative degree of limitation or hazard. The subclass is a grouping of soils with similar kinds of limitations and hazards.

The classification of organic soils for agricultural capability is based on certain assumptions that must be understood by those using capability maps or making capability ratings for various crops.

1. Capability ratings for drained areas assume continued subsidence rates of 2 to 5 cm annually. Therefore, the depth of the organic layer and the nature of underlying mineral material are taken into account in evaluating organic soils for agriculture.

2. The organic soil capability grouping is an interpretive classification designed to assess individual organic soils in terms of their limitations to development for, and production of, cereal grains, forage and pasture.

3. It is assumed that soils will receive good management, including drainage, control of subsidence and wind erosion and the crop growing and conservation practices that are feasible under a mechanized system of agriculture.

4. The soils within a capability class have similar degrees of soil limitation, but not necessarily similar kinds of limitation. The subclass provides information on the kind of limitation or hazard and the class indicates the intensity of the limitation. Organic soils in Class 1 have the least limitations and Class 7 soils have the most severe ones.

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[17] Leeson, Bruce, et al. 1969. An Organic Soil Capability Classification for Agriculture and a study of the soils of Simcoe County. Soil Sci. Dept., Ont. Agric. College, Guelph, Ont.

[18] Mills G.F., et al. 1977. Organic Soils of the Roseau River Watershed in Manitoba. Inventory and Assessment for Agriculture. Monograph No. 17, Canada Department of Agriculture.

5. Organic soils that have been reclaimed and developed for agriculture are classified according to any continuing limitations that may affect the production of agricultural crops. Soils in the natural state are classified not only according to agricultural capability but also according to the apparent degree of difficulty of reclamation and development.

6. Location, distance to market, efficiency of transportation, financial state of the market, farm size and sociological influences do not constitute criteria for capability groupings.

7. Capability classes and capability definitions are subject to change as new information and methods concerning the manipulation of organic soils become available. At present, capability groupings of organic soils do not have the benefit of extensive regional research or experience in management for agriculture, as is the case with mineral soils.

Capability classes

The seven capability classes for organic soils are given below.

Class O1	Organic soils in this class have no limitations because of water, topography, or soil pH and are deep and level. They are located in areas that have mild or warm soil temperatures.
Class O2	Organic soils in this class have one limitation that somewhat restricts their use. The limitation may be soil temperature, coarse fragments, woody layers, salinity, depth, or slope.
Class O3	Organic soils in this class have moderately severe limitations that restrict the range of crops or require special management practices.
Class O4	Organic soils in this class have limitations that severely restrict the range of crops or require special development and management practices.
Class O5	Organic soils of this class have severe limitations that restrict the production of perennial forage or other specially adapted crops. Large-scale reclamation is not feasible[19].
Class O6	Organic soils in this class are capable of producing only indigenous crops and improvement practices are not feasible.
Class O7	Organic soils of this class have no potential for agriculture.

Capability subclasses

The intrinsic physical and chemical properties of organic soils, which are important for evaluating agricultural capability and for estimating the degree of difficulty for development, have been described by Leeson et al. (1969) and discussed with reference to Manitoba conditions by Mills et al. (1977). The subclass is a grouping of soils with similar kinds of limitations and hazards and indicates major limitation within the classes. These are adverse climate (C), excess water (groundwater level and flooding) (W), coarse wood fragments (L), degree of decomposition (H), nature of the surface materials (F), salinity (N), and depth of organic material and nature of underlying material (D).

Development difficulty ratings for organic soils

As well as evaluating potential capability, the system attempts to establish the relative degree of difficulty in carrying out reclamation or development on organic soils. Development difficulty ratings recognize that two organic soils may have similar agricultural capability according to their continuing limitations, but one may need much more extensive reclamation than the other. The ratings are based on evaluations of organic soils in their present or natural state, and are important in establishing priorities for the areas of soils to be reclaimed. Three relative degrees of difficulty in overcoming limitations or hazards to use are recognized.

1. *Minor development difficulty.* Only minor reclamation is required to overcome limitations to use of soils rated 1. Minor reclamation is considered to consist of work that can be carried out by a single operator and that does not require cooperation among several. Such operations would include leveling rough surfaces, removing woody surface layers and land clearing.

2. *Major development difficulty, reclamation warranted.* Major reclamation is required for soils rated 2 and is warranted when soil potential is high. Major reclamation needs cooperation between adjoining operators or outside financial assistance, or both. Major reclamation operations include drainage, construction of water control works, or correction of very low or very high pH.

3. *Major development difficulty, reclamation seldom warranted.* Organic soils rated 3 can be developed only through very large reclama-

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[19] In the foregoing definitions, the term "feasible" implies that it is within present-day economic and technological possibility for an individual farmer to make such improvement and it does not require a major reclamation project to do so.

tion projects. Major reclamation is seldom warranted because the hazards are serious enough to constitute some continuing limitation that reduces the agricultural capability.

Many features of organic soils that affect their agricultural capability also affect the degree of development difficulty experienced in reclaiming them and the costs of maintaining their productive capacity. The features of organic soils important to rating the degree of development difficulty are vegetative cover, excess water, inundation, surface roughness, coarse wood fragments, degree of decomposition and depth of organic materials. The relative limitation that each feature places on reclamation often depends on organic materials and soil types; in other cases, it depends on the physiographic position of the soil area compared with that of other organic and mineral soils.

Capability and Degree of Development Difficulty Ratings - Organic Soils

Most organic soils in The Pas map area, experience a shorter growing season than mineral soils because of their thermal properties. These soils do not warm up as rapidly as mineral soils because of the insulating effect of organic residues. This limitation is hazardous to crop production and can cause lower crop yields, or crop failures. There are no organic soils in Classes 1,2 or 3 in this map area because of their associated cold thermal regime. The distribution of organic soil capability classes and subclasses and ratings for the degree of development difficulty are given in Table 52.

Class O 4

Organic soils of Class 4 have severe limitations that restrict the range of crops or that require special development and management practices.

O 4W These are poorly to very poorly drained soils that are derived from moderately decomposed fen peat. The soils in this subclass are Cayer series, Kircro series, Stead series, Halcrow series and Katimik series. The smooth, level, organic deposits range in depth from 60 cm to more than 3 m in places. Their degree of decomposition and the nature of plant residues from which the peat has been derived are normally very uniform. These soils usually range from medium acid to neutral in reaction and have a high water holding capacity. Water movement is moderately slow and equivalent to that in a uniform, medium textured mineral soil. They are usually underlain by loamy to clayey textured lacustrine sediments.

The shallow members of this group, the Cayer, Kircro, and Howell soils, are rated as having a minor degree of development difficulty. Lowering and controlling the water table between 45 and 90 cm of the surface in these soils is not a major reclamation problem.

The deeper Katimik and Stead soils are rated as having a major degree of development difficulty. Most of these soils normally occur in the center of large peatland areas and usually serve as catchment basins to adjacent shallow organic and mineral uplands soils. Because of this, major reclamation is required to remove large volumes of water.

		Extent (ha)	*% of Map Area*
Ca	Cayer	107 768	8.43
Hw	Howell	9 756	.76
Kc	Kircro	15 515	1.21
Kt	Katimik	16 475	1.29
Sd	Stead	34 628	2.71
	Total	184 142	14.40

O 4WL These poorly drained organic soils are derived from moderately well to well decomposed forest peat. The organic soil complexes in this subclass are Guy Hill complex, Okno complex, Orok complex, Rat River complex and Waskwei complex. These soils occur on densely tree covered, hummocky surfaced, woody organic deposits 60 cm to about 1.5 m. Waskwei complex occurs on similar materials but has depths greater than 1.6 meters. They are found on slightly better drained, elevated areas or very gently sloping to nearly level bog landforms near the margins of peatlands.

Forest peat is derived from black spruce and some tamarack, feathermosses, ericaceous shrubs, and other herbaceous plants. The peat material is usually very dark brown to nearly black, and has an amorphous structure. In most cases it has layers of coarse, woody fragments and roots, stems and branches of black spruce and tamarack. The peat is usually strongly acid to neutral in reaction. Water movement in these soils varies from moderately slow and slow in the dense, well decomposed layers to very rapid in the coarse, woody, less well decomposed layers. The underlying sandy to clayey lacustrine soils are stone free and usually moderately calcareous.

These soils have a major degree of development difficulty rating because of the dense forest cover, excess water from surrounding uplands, the hummocky surface and in particular the rather high content of coarse woody material in the soil itself. This woody material is much more resistant to decomposition than herbaceous residues and contributes significantly to a rough, uneven seedbed. The high degree of decomposition in some layers of these soils contributes to poor water movement and consequently limits the satisfactory control of the water table at 45 to 90 cm below the surface.

		Extent (ha)	*% of Map Area*
Ghx	Guy Hill	3 476	.27
Ox	Okno	10 001	.78
Orx	Orok	12 059	.94
Rrx	Rat River	8 096	.63
Wsx	Waskwei	6 565	.51
	Total	40 197	3.13
	Total Class O 4	224 339	17.53

Class O 5

Organic soils of Class 5 have severe limitations that restrict their use to the production of perennial forage or other specially adapted crops.

O 5WD These poorly drained organic soils are derived from thin deposits of fen that overlie very stony to excessively stony, extremely calcareous till. The soil series in this subclass is the Crane series. These soils are usually 60 to 130 cm thick, have agronomic characteristics and degrees of development difficulty similar to those of the Cayer and Kircro soils. However, because stones from the underlying till would add to the management problems of these soils if the organic materials were lost because of subsidense or other causes, their suitability for agriculture is further limited.

Their degree of development difficulty is minor. However, if the organic deposit is very shallow, less than 60 cm thick, the underlying stony till would certainly increase the difficulty of reclaiming these soils.

		Extent (ha)	*% of Map Area*
Cr	Crane	15 246	1.19
	Total Class O 5	15 246	1.19

Class O 6

Organic soils in Class 6 are capable only of producing indigenous crops and improvement practices are usually not feasible.

O 6W These poorly drained organic soils are derived from thin (Reed Lake complex) and deep deposits (Rock Island complex) of fen peat underlain by lacustrine sediments. These soils are very similar to those described in Capability Class O 4W, with the exception that minor permafrost areas occur within these complexes. Also a minor amount of wooded forest peat soils occur within these complexes. These are much cooler organic soils compared to those in Capability Class O 4W.

The degree of development difficulty is major.

		Extent (ha)	*% of Map Area*
Rex	Reed Lake	669	.05
Rlx	Rock Island	1 115	.09
	Total	1 784	.14

O 6WD These poorly drained organic soils are derived from thin, usually 60 to 130 cm thick, moderately to moderately well decomposed forest peat that overlies very stony to excessively stony, extremely calcareous till. These soils occur on stunted tree covered, hummocky surfaced woody organic deposits. These soils have a 15 to 60 cm fibric Sphagnum surface which is relatively undecomposed. The peat is usually strongly acid to neutral in reaction.

Forest peat is derived from stunted black spruce and tamarack, feathermosse, ericaceous shrubs, Sphagnum spp. and other herbaceous plants. The forest peat material is usually very dark brown to nearly black, and has an amorphous structure. While the well preserved sphagnnum surface is yellowish brown in color, and loose the near surface layers and entire sphagnum plants can be identified. The sphagnum material is usually extremely to strongly acid. In some places it has layers of coarse woody fragments and roots, stems and branches of black spruce and tamarack. Water movement in surface sphagnum layer is very rapid.

The soils have a major degree of development difficulty rating because of required water control structures and correction of very low pH.

		Extent (ha)	*% of Map Area*
Gdx	Grindstone	8 277	.65
Hl	Halcrow	5 907	.46
Kx	Kilkenny	10 686	.84
Llx	Lamb Lake	35 422	2.77
	Total	60 292	4.72

O 6WF These poorly drained organic soils are derived from thick layers of extremely acid, fairly undecomposed Sphagnum mosses that commonly overlie lacustrine sediments. The soils in this subclass are the Catfish Point series, Chocolate complex, Molson complex, Nekik Lake complex and Whithorn complex. These organic deposits are usually found on sites that are isolated from mineral influenced groundwater. The soils occur under open stands of stunted black spruce. The soils occur under open stands of stunted black spruce and tamarack. Sphagnum mosses and ericaceous shrubs such as bearberry and Labrador-tea form the dominant vegetation.

Sphagnum moss peat is usually found in a well preserved or fibric state. It is usually light yellowish brown and loose in layers near the surface entire sphagnum plants are readily identified. The material is usually extremely acid to very strongly acid. At lower depths, sphagnum peat becomes reddish yellow to dark brown, extremely to strongly acid, compacted, horizontally layered, and it has very low volume weight. This material contains some wood. In deeper deposits, those approaching 1.5 m in depth, the sphagnum is often underlain by forest or fen peat or both. Nutrient supply for plant growth is very low in these soils. Water movement, particularly in the surface layers is very rapid.

The soils have a major degree of development difficulty rating because of required major water control structures and correction of very low pH.

		Extent (ha)	*% of Map Area*
Cp	Catfish Point	1 210	.09
Chx	Chocolate	1 015	.08
Mx	Molson	51 560	4.03
Nlx	Nekik Lake	913	.07
Srx	Sand River	11 387	.89
Whx	Whithorn	18 470	1.44
	Total	84 555	6.60
	Total Class O 6	146 631	11.46

Class O 7

Organic soils of this class have no potential for agriculture.

O 7W These poorly drained organic soils are derived from deep fen deposits which have a aquic layer (the surface material floats on water) in the profile. Most of these soils normally occur in the center of large peatland areas and usually serve as catchment basins to adjacent shallower organic and upland mineral soils. Because of the problem of water and floating surface these soils have a major development difficulty rating to such an extent that with reclamation is not being warranted.

		Extent (ha)	*% of Map Area*
Ov	Overflowing	11 597	.91

The remaining portion of the map area consists of water bodies and The Pasquia Land Settlement Project which had already been mapped and reported on in Report No. 11. A summary of the agricultural capability classes in The Pas Map Area are listed in Table 53.

TABLE 53
Summary of Agricultural Capability Classes in The Pas Map Area

Capability Class	*Extent (ha)*	*% of Map Area*
Mineral Soils		
1	—	—
2	43 927	3.44
3	38 808	3.02
4	73 608	5.75
5	18 247	1.37
6	183 043	14.32
7	36 262	2.89
Organic Soils		
04	224 339	17.53
05	15 246	1.19
06	146 631	11.46
07	11 597	.91
Waterbodies	430 480	33.72
Pasquia Settlement	56 288	4.40
Total	1 278 476	100.00

Soil Suitability for Irrigated Agriculture

The appraisal of land for irrigation suitability involves an evaluation of physical, economic and sociological factors of the area. Physical factors such as soil, water and climate determine the potential of an area to produce crops. The economic factors determine the kind of crops grown and the monetary returns that might be expected. The less tangible sociological factors include the available human resources and the influences that intensive and specialized cultural practises may have on the community. However, from the stand-point of determining the suitability of soil for irrigation, only the physical factors of the land resource will be considered in this report.

The irrigation suitability classification for land is based on predictions of soil behavior under controlled conditions of soil moisture and intensive cultural practises. It requires a comprehensive knowledge of existing soil properties such as the natural soil water regime and the degree of salinity. These two factors are particularly important because of their affect on plant growth and because they are the properties most susceptible to change under drastically altered soil water regimes. For irrigation purposes, both salinity and drainage must be appraised in terms of the anticipated effects on future productivity.

Criteria for Determining the Irrigation Suitability of Soils

In determining the irrigation suitability of soils, the permanent nature and non-permanent nature of both internal and external soil characteristics are considered. Evaluation of these criteria provide guidelines to assist in the design and management of irrigation projects. The criteria are summarized in Table 54.

TABLE 54
Criteria for Determining the Irrigation Suitability of Soils*

Internal Soil Characteristics

Permanent	Non-permanent
1. Texture	5. Structure
2. Uniformity and Depth of Geologic Deposit	6. Drainage 7. Fertility
3. Hydraulic Conductivity	8. Reaction
4. Water Storage Capacity	9. Salinity
	10. Exchangeable Sodium - (S.A.R.)

External Soil Characteristics

11. Topography
12. Erosion
13. Stoniness
14. Vegetation Cover

*C.D.A. Handbook for the Classification of Irrigated Land in the Prairie Provinces, P.F.R.A., Regina, Sask., 1964 and Soils Report No. 17. Soils of the Portage la Prairie Area (1972), Manitoba Soil Survey.

Internal soil characteristics are those properties and conditions which exist below the soil surface. They can be grouped according to their amenability to change, i.e. permanent characteristics are those properties such as texture and water storage capacity which cannot be altered, while non-permanent features are those such as fertility and drainage which can be altered by specific management practises.

The classification of individual soil types for irrigation suitability serves as a general guide to rating soil areas according to their suitability for irrigation agriculture. The irrigation suitability is most easily determined and most satisfactory when the ratings can be applied to single mapping units representing uniform soil conditions found on uniform geological deposits. Areas comprised of two or more kinds of soils can be rated for the different soil types by estimating the proportion of each that is present in complex mapping units.

Where the underlying geological material is highly variable, the task of rating the soil becomes still more difficult. When rating the irrigation suitability of such soils an attempt is made to recognize all potentially unfavourable conditions related to variability of the subsoil.

The results of physical and chemical analyses are used to check and sometimes to determine the final rating. The weight given to soil properties such as clay content, sodium adsorbtion ratio (S.A.R.) and salinity is varied according to the nature of other factors such as depth of material, structure and type of deposition.

The most important step in rating soils for irrigation suitability is establishing their Class ie. whether it is a very good, good, fair or poor soil for irrigation. Often the Class rating is arrived at by the limitations imposed by a single soil property or by the cumulative effect of two or more properties. These conditions are identified as subclasses, but the potential for irrigation is reflected best in the Class rating.

1. Texture

Texture is a permanent property of soil that greatly affects its ability to retain and transmit water. In general, soils that range from moderately coarse to moderately fine in texture, are considered to be very good to good for irrigation.

Coarse textured sandy and gravelly soils tend to be deficient in water holding capacity and are excessively permeable resulting in very inefficient use of applied water.

The main effect of texture on irrigation suitability results from inferred relationships to saturation percentage and hydraulic conductivity.

2. Uniformity and Depth of Geological Deposit

Deep, uniform, permeable materials are the most desirable for irrigation purposes. Depth to impervious material should be sufficient to allow free drainage of the soil and to avoid the build-up of a water table.

3. Hydraulic Conductivity

Hydraulic conductivity is a measure of the transmissibility of water in soil and should be neither excessive nor too slow. Soils having disturbed hydraulic conductivities that range from 2.0 to 7.5 cm per hour have satisfactory water transmissibility. In general, fine textured soils have hydraulic conductivities that are too low and coarse textured soils have conductivities that are too high exceeding 7.5 cm per hour.

4. Water Holding Capacity

Water holding capacity is another permanent physical feature of soils that is dependent upon the texture of the soil. Good irrigation soils generally are able to store more than 15 cm of water in 1.2m of soil; fair irrigation soils hold between 10 to 15 cm of water. Coarse textured soils generally hold less than 10 cm.

5. Structure

Structure is a non-permanent characteristic of soil affecting permeability and tilth. Coarse textured, sandy soils usually have single grained structure that causes excessive permeability, poor tilth and a high susceptibility to erosion. Moderately coarse to moderately fine textured soils have dominantly granular structures which permit good but not excessive transmission of water, good tilth and reduces erosion. The fine textured clay soils may be granular in the plow layer due to high organic matter content, but tend to be very massive at depth as organic matter content decreases. Fine texture and massive structure combine to make subsurface layers of clay soils virtually impervious to water.

6. Drainage

Drainage is a non-permanent feature of soils that affects the economic soundness of irrigation development should the soil be otherwise suitable for irrigation. Moderately well drained to imperfectly drained, moderately coarse to moderately fine textured soils are considered to be suitable for irrigation. Imperfectly drained, impermeable fine textured clay soils are not suitable for irrigation. Poorly drained soils are not suitable for irrigation regardless of texture, if drainage improvement is not considered feasible.

The drainage factor takes into account surface and subsurface drainage characteristics as well as groundwater flow.

7. Fertility

The application of nitrogen, phosphorus, and in some cases, potassium fertilizer to all crops grown under dryland culture has proven to be a most profitable management practice in the area. While this may indicate a fertility problem of some measure, it is not one that is considered to be important in evaluating soils for irrigation, since the problem can be readily and economically overcome. However, it is important to emphasize that if crops are not adequately supplied with nutrients, they will not respond to addition of irrigation water.

8. Reaction

Soil reaction or the degree of acidity or alkalinity varies from neutral to moderately alkaline, a very acceptable range from the point of view of crop growth. For this area, reaction is not a critical factor in the irrigation suitability of soil.

9. Salinity

Soil salinity is not a problem in The Pas map sheet area as only 350 hectares of salt affected soils were mapped out.

TABLE 55
Land Classification Standards for Irrigation Suitability

Land Characteristics	Sub class	Class 1 - Very Good	Class 2 - Good	Class 3 - Fair	Class 4 - Poor
SOILS	S				
Texture					
very coarse textured very fine textured	v h	Fine sandy loams to clay loams	Laomy fine sand to light clay	Sand to permeable clay	Gravel to clay
Water holding capacity low available moisture capacity	q	40 to 60 sat. % >15 cm storage in 1.2m <10cm/hr. hydraulic cond.	35 to 65 sat. % >12.5 cm storage in 1.2m <12.5 cm/hr. hydraulic cond.	25 to 75 sat. % >7.5cm storage in 1.2m <17.5cm/hr. hydraulic cond.	<25 or > 75 sat. % <7.5cm storage in 1.2m >17.5cm/hr. hydraulic cond.
Geological Deposit shallow deposit over sand or gravel	k	.9m or more of fine sandy loam or heavier	.6m or more of fine sandy loam or heavier, or .75m plus of loamy fine sand or sandy loam	.5m or more of sandy loam or heavier, or, .6m plus of loamy sand	<.5m of sandy loam or heavier, or .6m of loamy sand or sand
shallow deposit over impervious substrata	b	>3m of permeable material	>2m of permeable material	>1m of permeable material	< 1m of permeable material
Salinity and Alkalinity[1],[2]	a	<4 ms/cm in 0-.6m <8 ms/cm below .6m <6 S.A.R.	< 4 ms/cm in 0-.6m < 12 ms/cm below .6m < 8 S.A.R.	< 8 ms/cm in 0-.6m < 15 ms/cm below .6m < 12 S.A.R.	> 8 ms/cm in 0-.6m > 15 ms/cm below .6m > 12 S.A.R.
EXTERNAL FEATURES					
Stones - rock clearing	r	None to light clearing	Light to medium clearing	Light to heavy clearing	Excessively stony
Topography' Slope excess gradient	T g	<1% and 0.1% in general gradient (0-3% slope)	< 3% in general gradient (3-5% slope)	<5% in general gradient (5-10% slope)	> 5% in general* gradient (>10% slope)**
DRAINAGE	D				
restricted outlet		No problem anticipated	Moderate drainage Problem anticipated but may be improved at relatively low cost	Moderate to severe drainage problem anticipated but may be improved by expensive but feasible measures	Drainage improvement not considered feasible
water table		below 2.4m most of year	could be above 1.5m for a short period, then recedes to 2.4m or lower	within 1.5m most of year	within 1m most of year

* Criteria for gravity (flood) irrigation requirements.

** Estimated adjustments to slope criteria for overhead or sprinkler type irrigation methods.

[1] If sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

[2] The degree of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each salinity class. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the acreage occupied by each salinity class.

10. Exchangeable Sodium (S.A.R.)

Exchangeable sodium or Sodium Absorption Ratio (S.A.R.) is low in most all soils in the map area. Only a few of the very saline soils have high and undesirable S.A.R. values. High S.A.R. values are associated with low hydraulic conductivity. Good irrigation soils have S.A.R. values of less than 6, fair soils have values between 6 and 8, poorly suited soils have values that exceed 8.

External soil characteristics that affect irrigation suitability are actually landscape features and include such attributes as slope, topography, erosion, stoniness and vegetation cover.

11. Topography

For the most part, topography determines the type of irrigation method that can be used. Land development requirements for gravity irrigation are governed by topographic features such as relief and percent slope which determine the ease or difficulty of conveying water over the land and applying it to crops. Land development for this type of irrigation includes clearing, leveling and the construction of permanent farm ditches, drains and water controls.

Where sprinkler irrigation units are used, the limits of slope and topographic pattern described in Table 55 can be significantly relaxed. As a general rule, land level enough to permit normal farming is level enough for installation of a sprinkler system. The complexity of slope will determine the type of sprinkler system most suitable. Stationary sprinkler systems can be used on almost any slope, while travelling sprinkler systems are generally limited to slopes of less than 10 percent (see Table 55).

12. Erosion

Erosion is not a limiting factor in assessing irrigation suitability of the soils in The Pas Map Area.

13. Stoniness

The stoniness factor is more important in assessing land development costs than in the actual soil rating for irrigation suitability.

14. Vegetation cover

Vegetation cover is primarily a consideration in the cost of land development. Land clearing may be dictated more by the method used to apply irrigation water than by the irrigation suitability of the particular soil. For example, trees and bushes along fence lines or small sloughs may need to be removed to permit passage of the sprinkler line and not because the soil itself is particularly desirable.

Irrigation Classification of Soils

The classification of soils for irrigation suitability consists of three categories: class, subclass and units.

1. The suitability class is the broadest and most important category. Soils are grouped into four classes grading from Class 1 which is very good to Class 4 which is poor. In each class, the soils have the same relative degree of limitation or hazard for irrigation use.

2. The suitability subclass identifies soils with similar kinds of limitations and hazards, such as soil factors (S), topography (T), and drainage(D). Limiting soil factors may include texture (h or v), water holding capacity and permeability (q), depth of permeable material (k or b), and salinity (a). Topographic limitations are primarily slope gradients (g). The class and subclass criteria are summarized in Table 55.

3. The suitability unit is a subdivision within the subclass category that groups together soils that will respond similarly to management.

Note 1: The classification must take into account all the soil factors previously discussed. Furthermore, the relation between chemical and physical properties of the soil must also be studied. For example, high and undesirable S.A.R. values may be associated with low, undesirable hydraulic conductivities; but if sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

Note 2: Salinity. It is most difficult and often impossible to properly assess or rate the conditions of undesirable salinity found in the soils of proposed irrigation projects. The degree or grade of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each class. Thus, where a number of soil profiles are sampled in one soil area or mapping unit, it is not uncommon to find that the salinity and S.A.R. values represent several or all of the grades recognized. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the hectarage occupied by each salinity class.

TABLE 56
Approximate Hectarage of the Irrigation Classes in The Pas Map Area

Class	*Suitability*	*Hectares*	*% of Total Area*
1	Very good	31 277	2.45
2	Good	3 407	.27
3	Fair	-	-
4	Poor	757 024	59.16
Water bodies		430 480	33.72
Pasquia Settlement		56 288	4.40
	Total	1 278 476	100.00

The soils of The Pas Map area are classified into four irrigation suitability classes based on the chemical, physical and related soil properties important to irrigation suitability. The class ratings are summarized in Table 52. and discussed in the following section. The hectarage of the various irrigation suitability classes in the map area is given in Table 56.

Class 1

These are soils of fine sandy loam to clay loam texture which have no significant limitations in use for irrigation. They have good water holding capacity, good permeability, low salt content, good drainage and satisfactory topography. The soils in this class are rated very good for irrigation.

		Hectares	*% of Area*
C	Carrot	10 810	.85
Ho	Homestead	1 103	.09
N	Nels	19 364	1.51
	Total Class 1	31 277	2.45

Class 2

These are soils of loamy fine sand to clay loam texture which have slight limitations in use for irrigation. This class includes soil limitations (S) such as water holding capacity and permeability (q), depth of material (b,k), salt content (a), stoniness (r), topographic limitations (T), such as slope pattern (g); or drainage limitations (D) such as surface drainage or depth to water table. The soils in this class are rated good for irrigation.

2D These are imperfectly drained soils developed on medium to moderately fine textured materials. These soils have a slight drainage problem due to seasonal high water table in some years.

		Hectares	*% of Area*
Dv	Duck River	2 886	.23
Sf	Swanford	521	.04
	Total Class 2	3 407	.27

Class 3

These are coarse to moderately fine textured soils having some unfavorable characteristics that limit production and cause management problems under irrigation. These include soil , topography , or drainage factors that are more restrictive than in Class 2. The soils in this class have a fair to marginal suitability for irrigation.

No soils from The Pas area fell in this class.

Class 4

Soils in this class are considered to be poor to unsuitable for irrigation because of severe drainage problems, impermeability of geologic materials, salinity, very low water retention capacity, very rapid permeability, topography or a combination of these problems. The soils in this class are as follows.

4D1 These are coarse to fine textured poorly drained mineral soils some of which are underlain by till. Water tables are at or near the surface for most of the growing season and drainage improvement for irrigation is considered not feasible. The soils are.

		Hectares	*% of Area*
As	Askandigau, clay	3 089	.24
As(P)	Askandigau, peaty clay	8 627	.67
B	Big Lake, loam	16 297	1.27
B(d)	Big Lake, loam, drained	410	.03
B(P)	Big Lake, loam, peaty	22 637	1.77
Be(d)	Big Eddy, clay, drained	571	.04
Ea(P)	Easterville, gravelly, peaty	1 296	.10
Fo	Foley, loam	521	.04
Fo(P)	Foley, loam, peaty	768	.06
Ko	Koostatak, clay	1 528	.7
Ko(P)	Koostatak, clay, peaty	3 088	.24
Lp	Le Pas, clay	8 909	.70
Mh	Marsh	15 931	1.25
Nb(P)	Napanee Bay, clay, peaty	356	.03
No	Novra, loam	1 276	.10
No(P)	Novra, loam, peaty	1 874	.15
Nr	Norris, gravel	3 161	.25
Nr(P)	Norris, gravel, peaty	7 622	.60
P	Pasquia, loam	6 075	.48
P(d)	Pasquia, loam, drained	1 052	.08
P(P)	Pasquia, loam, peaty	7 839	.61
Sm(P)	Sagemace, clay, peaty	5 441	.43
	Total	118 368	9.26

4D2 These are poorly to very poorly drained organic soils. Water tables are at or near the surface for most of the growing season and drainage improvement for irrigation is considered not feasible. The soils are.

		Hectares	*% of Area*
Ca	Cayer	107 768	8.43
Chx	Chocolate	1 015	.08
Cp	Catfish Point	1 210	.09
Cr	Crane	15 246	1.19
Gdx	Grindstone	8 277	.65
Ghx	Guy Hill	3 476	.27
Hl	Halcrow	5 907	.46
Hw	Howell	9 756	.76
Kc	Kircro	15 515	1.21
Kt	Katimik	16 475	1.29
Kx	Kilkenny	10 686	.84
Llx	Lamb Lake	35 422	2.77
Mx	Molson	51 560	4.03
Nlx	Nekik Lake	913	.07
Orx	Orok	7 059	.94
Ox	Okno	10 001	.78
Ov	Overflowing	11 597	.91
Rex	Reed Lake	669	.05
Rlx	Rock Island	1 115	.09
Rrx	Rat River	8 096	.63
Sd	Stead	34 628	2.71
Srx	Sand River	11 387	.89
Whx	Whithorn	18 470	1.44
Wsx	Waskwei	6 565	.51
	Total	397 813	31.09

4ShD These are fine textured, imperfectly drained soils that have low permeability and high moisture retention capacity.

		Hectares	*% of Area*
Dp	Davis Point, clay	6 380	.50
Mg	Mantagao, clay	4 893	.38
Mu	Mukatawa, clay	546	.04
Wr	Warpath, clay	7 812	1.00
	Total	24 631	1.92

4DSr These poorly drained soils are developed on medium to moderately fine textured very stony till. The main limitations are water tables at or near the surface throughout the growing season and excessively stony conditions that do not permit cultivation without extensive stone clearing.

		Hectares	*% of Area*
Dr	Dering, clay loam	17 044	1.33
Dr(P)	Dering, clay loam, peaty	43 381	3.39
Ml	Meleb, clay loam	275	.02
Ml(P)	Meleb, clay loam, peaty	8 713	.68
	Total	69 413	5.42

4SvD These imperfectly drained gravelly soils have very rapid permeability, low moisture retention capacity and have water tables at or near the surface through most of the growing season.

		Hectares	*% of Area*
Hrx	Horseshoe Island, sand and gravel	3 544	.27
Tux	Tremauden, sand and gravel	2 694	.21
	Total	6 238	.48

4DSa These are poorly drained medium to moderately fine textured till soils which contain soluable salts in sufficient quantity to affect crop growth. Water tables are at or near the surface throughout the growing season and drainage improvement for irrigation is considered not feasible. The soils are.

		Hectares	*% of Area*
Sfx	Saline Flats, loam to clay loam	350	.03

4Sbr These are well drained medium to moderately fine textured soils underlain by limestone bedrock within 1 m of the soil surface. Shallow depth to bedrock and the excessively stony conditions of these soils are severe limitations to their use for irrigation. The soils are.

		Hectares	*% of Area*
cR	Limestone bedrock	5 430	.42
Li	Limestone Point, clay loam	20 422	1.60
Li(s)	Limestone Point, clay loam, shallow	14 286	1.7
	Total	40 138	3.14

4Sh These are well drained fine textured soils which have low permeability and internal drainage problems because of their texture and massive structure in subsurface horizons.

		Hectares	*% of Area*
Cl	Cedar Lake, clay	16 971	1.33
Ei	Egg Island, clay	994	.08
Hb	Homebrook, clay	2 863	.22
Ki	Kinwow, clay	1 395	.11
Lt	Lettonia, clay	158	.01
	Total	22 381	1.75

4Sr These are well drained soils developed on medium to moderately fine textured stony till. The main limitations is excessive stony surface conditions which do not permit cultivation without extensive stone clearing. The soils are.

		Hectares	*% of Area*
At	Atikameg, clay loam	17 925	1.40
Fd	Fairford, clay loam	1 497	.7
Wy	Westray, clay loam	1 073	.08
	Total	20 495	1.60

4SrD These are imperfectly drained soils developed on medium to moderately fine textured stony till. High seasonal water table and excessive stony surface conditions limit these soils for irrigation use. These soils are.

		Hectares	*% of Area*
Bc	Birch Bay, clay loam	1 792	.14
Ci	Chitek, clay loam	48 425	3.79
In	Inwood, clay loam	281	.02
	Total	50 498	3.95

4Svq These well drained gravelly soils have very low water holding capacity and very rapid permeability. The soils are.

		Hectares	*% of Area*
Fx	Freshford, gravel	4 498	.35
Sb	Sand beaches, sand and cobbles	265	.02
Sox	Soul Lake, gravel	1 936	.15
	Total	6 699	.52
	Total Class 4	757 024	59.16

FORESTRY

Area and Volume of Forests

Forest statistics are available for Forest Management Units as established by the Manitoba Department of Mines Resources and Environmental Management[20]. This map area contains within its boundaries Forest Management Unit 52 and parts of 47,49,53,55,56 and 57 (Figure 32). It

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[20] Kotowycz, A.J., M. Kaye, C.D. Rannard, R. Lamont, C.J. Jeffery and R.O. Regan, 1975. The Forests of Manitoba, Forestry Team. Manitoba Dept. of Mines Resources and Environmental Management. Winnipeg. 82pp.

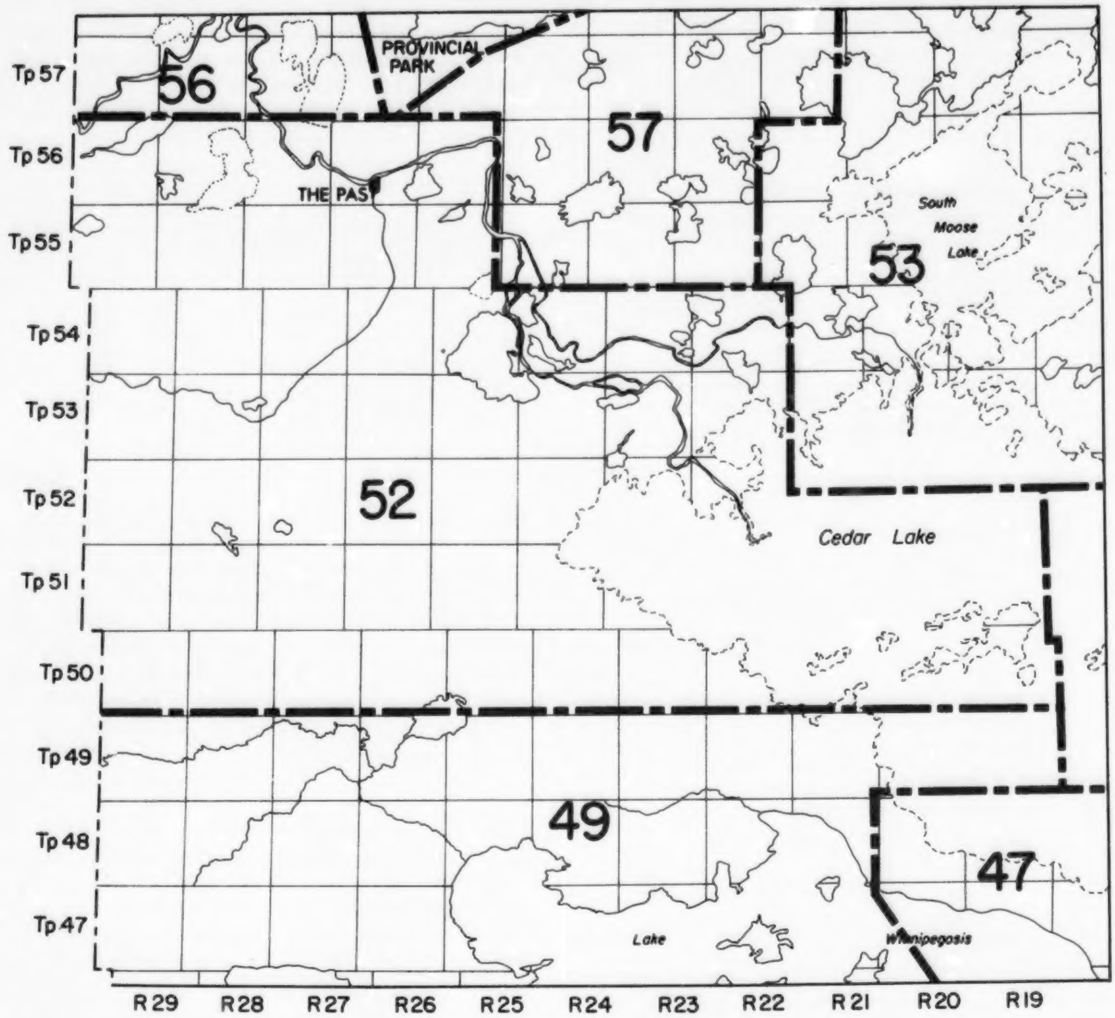

FIGURE 32
Location of Forest Management Unit 52 within The Pas Map Area.

would be very difficult to report data on parts of Forest Management Units, therefore Forest Management Unit (F.M.U.) 52 will be used as an example. It is centrally located and covers approximately one half the area of The Pas map sheet. The majority of the map sheet is coniferous forest, with the exception of the Saskatchewan River delta which is predominantly hardwood forest. Recent forest statistics for The Pas area indicate that the proportion of the area classified as productive forest is greater than 70%, except for the Saskatchewan River Delta area which is 50 to 70% productive. Mean annual growth increments for The Pas map sheet, are less than .8 cu metres/hectare/year in some organic areas to greater than 2 cu metres/hectare per year in the Saskatchewan River delta area. The majority of the area falls in the 0.8 to 1.0 cu metre/hectare/year increment.

Net merchantable volume by tree species within FMU 52 is shown in Table 57. The dominance of softwood is evident from Table 57 as about 70 percent of the merchantable volume is composed of softwoods; black spruce, white spruce, being the dominant species. Approximately 58% of the softwood volume consists of immature trees of small diameter. The majority of wood cut goes into pulpwood production.

TABLE 57
Distribution of Net Merchantable Volume in 100's Cubic Feet/Acre/Year in Forest Management Unit 52.

(To convert cu. ft./acre/yr. to cu m/ha/yr. multiply x .07)

Forest Type and Species	Cutting Class		Total
	3	4 and 5	
	(intermediate age)	(mature and overmature)	
SOFTWOODS			
Jack pine	136,790	119,830	256,620
Black spruce	216,940	143,180	360,120
White spruce	47,740	39,050	86,790
Balsam fir	2,690	2,430	5,120
Tamarack	13,470	4,030	17,500
TOTAL SOFTWOODS	417,630	308,520	726,150
HARDWOODS			
Trembling aspen	50,270	56,310	106,580
Balsam poplar	28,850	101,450	130,300
White birch	7,110	7,780	14,890
Other	12,920	42,450	55,370
TOTAL HARDWOODS	99,150	207,990	307,140
TOTAL WOOD VOLUME	516,780	516,510	1,033,290

* Kotowycz, A.J., M. Kaye, C.D. Rannard, R. Lamont, C.J. Jeffery and R.O., Regan. 1975. The Forests of Manitoba. Forestry Team. Manitoba Dept. of Mines Resorces and Environmental Management Winnipeg. 82 pp.

Forest Utilization

The forests are utilized at the present time by the Manitoba Forest Resources Ltd (MFR) for lumber and pulpwood production. The majority of the wood cut goes into pulpwood production while the larger diameter trees go into dimensional lumber production.

Regeneration Practices

A number of factors influence the method of establishing tree seedlings, but probably the most important are soil type, soil moisture, relief and aspect. These environmental factors control the kind of species that can be grown on a particular site, in a given climatic zone. They also determine the vigour and kind of competing vegetation that will be present. Cutting method, time elapsed since cutting and the availability of tree seed will govern the practices to be used to establish a future forest stand.

Softwood species can be regenerated from seed, either from natural sources or applied artificially or by planting. Ground preparation on all but very dry or wet sites is essential for seedlings to survive in adequate numbers. Ground preparation or scarification consists of the removal or disturbance of the organic surface horizons to expose the underlying mineral soil. This provides a seedbed favourable for the germination of tree seeds and a habitat with reduced vegetative competition in which the seedlings can develop at an optimum rate. During scarification by mechanical means, care must be taken not to remove all of the thin top soil horizon and not to create trenches where water may collect or initiate erosion.

White spruce regeneration can be obtained naturally from seed after modified clear cutting or partial cutting of the original stand on dry and fresh sites provided the seedbed is prepared immediately after the cut. On moist sites in the High Boreal-temperate and Low Boreal regions, regeneration proceeds naturally although vegetative competition is greater. If the seed source is removed by clear cutting, or the stand did not contain spruce, the scarified areas will have to be planted or seeded. In general, planting is the most successful method of establishing white spruce after clear cutting or fire.

Favourable seedbeds for black spruce are usually present on wet and very wet sites in the High Boreal-temperate and Low Boreal regions. On moderately fresh to very moist sites throughout this region, some form of site treatment must be undertaken to provide a favorable seedbed. If a seed source is lacking on wet mineral soil sites, black spruce may be planted on overturned furrows. Sometimes burning is required to remove slash piles which cover good seedbeds.

Jack pine regeneration may be obtained on dry and fresh sites throughout the High Boreal-temperate and Low Boreal regions usually by scarification after clear cutting and scattering seed-bearing cones on the seedbed. On very dry sites regeneration may be obtained by scattering cones on an unprepared seedbed, but planting furrows is usually more successful. On moist sites, scarification in preparation for seeding or planting should be more thorough than on fresh sites because of more vigorous vegetative competition.

Trembling aspen regenerates well from suckers after clear cutting or after light or moderate fire[21]. Studies indicate that soil temperature is an important factor in the formation of suckers. In general, burning of heavily cut areas increases the number of suckers because of the increased heat absorption of the blackened soil surface. Repeated severe fires weaken the species and eliminates aspen entirely.

Balsam poplar, like aspen, regenerates well from suckers. The suckering habit of this species is similar to that of aspen. Suckering takes place after clear cutting, appearing late in summer and growing very rapidly, sometimes out growing aspen. Reproduction from seed is important in such areas as recently deposited alluvium where the species did not occur before.

Forest Land Use Capability Classification

The soils of The Pas area are classified according to their capability to produce forest crops. The best forest lands are those capable of producing the greatest volume of a variety of regionally adapted species, and the poorest lands are those capable of supporting low volumes of a few species. Medium classes produce moderate volumes of several species, or can grow relatively high volumes of a few species only.

Mensuration of the forests in The Pas map area was carried out during the Canada Land Inventory forest capability study of The Pas map sheet[22]. Productivity measurements were obtained from the best observed stands and individual trees on the major soil types within the map area or in the immediate vicinity. These productivity figures were extrapolated to similar soil types for which mensurational data did not exist,

The forest land use capability is expressed in seven classes. Each class is characterized by a range of mean annual increment in gross merchantable cubic metres of wood volume per hectare, as defined by the Canada Land Inventory program[23]. Subclasses, based on factors that limit tree growth, follow the Canada Land Inventory definitions. Subclass symbols, when shown always represent a limitation to growth and are used only when the limitations they represent affect the class level. When the limitations are advantageous or not severe enough to affect class level, they are not shown. The subclass definitions are as follows:

Climate A limitation denoting a significant adverse departure from what is considered the median climate of the region, that is as a result of local climate; adverse regional climate is expressed by the class level.

Subclass A	Droughty or arid conditions as a result of climate.
Subclass C	A combination of more than one climatic factor or when it is not possible to decide which of two or more features of climate is significant.
Subclass H	Low temperatures or short growing season.
Subclass U	Exposure.

Soil Moisture A limitation denoting a soil moisture condition less than optimum for the growth of commercial forests but not including inundation.

Subclass M	Deficiency of soil moisture during at least part of the growing season. Deficient moisture is generally due to the coarse texture of the soil, shallowness of soil over bedrock, or slope.
Subclass W	Excess of soil moisture during at least part of the growing season. Excess moisture is generally due to slow internal drainage caused by fine texture of the soil, either on the surface or in layers, high water table in depressions, or low surface slope gradients.
Subclass X	A pattern of "M" and "W" too intimately associated to map separately.

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[21] Jarvis, J.H., G. A. Steneker, R.M. Waldron, J.C. Lees. 1966. Review of silvicultural research. White Spruce and trembling aspen cover types, Mixed Forest Section, Boreal Forest Region, Alberta-Saskatchewan-Manitoba. Forestry Branch, Departmental Publication No. 1156, 1966.

[22] Gimbarzevsky P. and Zoltai, S.C. 1971. Land capability for forestry of The Pas map sheet 63F. Canada Land Inventory, Dept. of Regional and Economic Expansion.

[23] McCormack, R.J., 1970. Land capability classification for forestry. Report No. 4, 2nd Edition. Department of Forestry and Rural Development.

Permeability and Depth of Rooting Zone Denotes limitations of soil permeability or physical limitation to rooting depth.

Subclass D	Physical restriction to rooting caused by dense or consolidated layers other than bedrock.
Subclass R	Restriction of rooting zone by bedrock.

Soil Factors Denotes factors of the soil which individually or in combination, adversely affect growth.

Subclass F	Insufficient supply of nutrients for optimum growth.
Subclass I	Periodic inundation by rivers or lakes.
Subclass L	Nutritional problems associated with high levels of carbonates.
Subclass N	Excessive levels of soluble salts in the soil.

Forest capability in The Pas map area is affected by over-riding climatic limitations. The fairly short growing season, low precipitation, occasional droughts and fairly high evapotranspiration combine to make Class 3 the highest rating in the area. Locally, under unusually favourable conditions the productivity may be one class higher.

In addition to climatic limitations, various combinations of soil and landscape features affect forest productivity in the The Pas map area. One of these conditions is associated with the occurrence of free lime carbonate in the soils. The effect of such high levels of carbonates is to restrict soil profile development and inhibit the decomposition of non-calcareous rock fragments. In addition, accumulation of organic matter is restricted to a much shallower depth than for less calcareous soils. Organic matter is largely concentrated in the surface 15 cm in highly calcareous soils. In contrast, organic matter accumulates to greater depths in soils developed on less calcareous parent materials.

In addition to its effect on soil morphology high levels of free lime are associated with nutritional problems which are not so evident in cultivated agricultural crops receiving annual applications of nutrients required for plant growth.

Calcium is an essential plant nutrient for tree growth, but excessive amounts of lime carbonates in a soil may aggravate or disturb the soil nutrient balance through the activity of the $CaCO_3$ and the associated soil pH. At pH levels above 5.5, phosphates are adsorbed on to clay surfaces making them somewhat unavailable to plants. With increasing pH, phosphate solubility is gradually controlled by reactions with calcium in which it is adsorbed on to calcite crystals and precipitates in a form that is mostly unavailable. In addition to reaction with phosphates, excess lime may induce deficiencies in iron, manganese, copper, zinc and boron.

Other soil factors affecting forest capability in The Pas map area are associated with soil drainage, and restrictions to rooting depth resulting from dense soil materials or bedrock. Seasonal soil moisture deficit limits forest growth on well drained sand and gravel ridges and soil moisture excess limits productivity on most poorly drained soils. Local areas of limestone bedrock near the surface restrict rooting depth and reduce productivity.

Soil Capability for Forestry

A summary of forest land capability classes (Table 59), and subclasses occurring within The Pas area is presented in Table 58. A description of the soils and their properties affecting capability is given in the following section.

Class 1 On these lands there are no important limitations to the growth of commercial forests. The productivity is greater than 7.8 cubic metres per hectare per year. No soils in The Pas area are listed in this class.

Class 2 On these lands there are slight limitations to the growth of commercial forests. Productivity is between 6.4 and 7.7 cubic metres per hectare per year. No soils in The Pas area are listed in this class.

Class 3 Lands in this class have level to gently sloping relief, are well to imperfectly drained, have good water holding capacity and are high in inherent fertility. Productivity is between 5 and 6.3 cubic metres per hectare per year.

Subclass 3a — Soils in this subclass are developed on well drained moderately to strongly calcareous lacustrine clays to clay till. These soils are well suited for white spruce, trembling aspen and balsam poplar. These soils are:

		Extent (ha)	*% of Map Area*
Cl	Cedar Lake	16 971	1.33
Dp	Davis Point	6 380	.50
Ei	Egg Island	994	.08
Hb	Homebrook	2 863	.22
Ki	Kinwow	1 395	.11
	Total	28 603	2.24

TABLE 58

Summary of Soils Showing Their Major Characteristics and Their Interpreted Classification for Forestry

Soil Symbol	Soil Name	Surface Texture	Phase	Drainage	Subgroup	Total Extent (hectares)	% of Area	Forest Capability
As	Askandigau	Clay	—	Poor	Rego Gleysol	3,089	.24	6W1
As(P)	Askandigau	Clay	Peaty	Poor	Rego Gleysol	8,627	.67	6W1
At	Atikameg	Loam to clay loam		Well	Eluviated Eutric Brunisol	17,925	1.40	4L1
B	Big Lake	Loam to clay loam	Carbonated	Poor	Rego Gleysol	16,197	1.27	7W1
B(d)	Big Lake	Loam to clay loam	Carbonated Drained	Poor	Rego Gleysol	410	.03	4W2
B(P)	Big Lake	Loam to clay loam	Carbonated Peaty	Poor	Rego Gleysol	22,637	1.77	7W1
Bc	Birch Bay	Loam to clay loam		Imperfect	Gleyed Eluviated Eutric Brunisol	1,792	.14	5LR
Be(d)	Big Eddy	Clay	Carbonated Drained	Poor	Rego Gleysol	571	.04	4W2
C	Carrot	Loam to clay loam		Imperfect	Gleyed Cumulic Regosol	10,810	.85	3b
Ca	Cayer	Organic		Very poor	Terric Mesisol	107,768	8.43	7W2
Chx	Chocolate Complex	Organic		Very poor	Terric Mesisol, Terric Fibric Mesisol, Terric Fibrisol	1,015	.08	7WF
Ci	Chitek	Loam to clay loam		Imperfect	Gleyed Eluviated Eutric Brunisol	48,425	3.79	4L2
Cl	Cedar Lake	Clay		Well	Orthic Gray Luvisol	16,971	1.33	3a
Cp	Catfish Point	Organic		Very poor	Terric Mesic Fibrisol	1,210	.09	7WF
cR	Carbonate Bedrock	Bedrock		Rapid		5,430	.42	7MR
Cr	Crane	Organic		Very poor	Terric Mesisol	15,246	1.19	7W2
Dp	Davis Point	Clay		Imperfect	Gleyed Dark Gray	6,380	.50	3a
Dr	Dering	Loam to clay loam	Carbonated	Poor	Rego Gleysol	17,044	1.33	6W1
Dr(P)	Dering	Loam to clay loam	Carbonated Peaty	Poor	Rego Gleysol	43,381	3.39	6W1
Dv	Duck River	Loam		Imperfect	Gleyed Dark Gray	2,886	.23	3c
Ea(P)	Easterville	Coarse sand and gravel	Carbonated Peaty	Poor	Rego Gleysol	1,296	.10	6W1
Ei	Egg Island	Clay	Shallow lithic	Well	Orthic Gray Luvisol	994	.08	3a
Fd	Fairford	Loam to clay loam		Well	Eluviated Eutric Brunisol	1,497	.12	4L1
Fo	Foley	Loam	Carbonated	Poor	Rego Humic Gleysol	521	.04	7W1
Fo(P)	Foley	Loam	Carbonated Peaty	Poor	Rego Humic Gleysol	768	.06	7W1
Fx	Freshford Complex	Coarse sand and gravel		Well	Eluviated Eutric Brunisol	4,498	.35	5M
Gdx	Grindstone Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase, Terric Fibric Mesisol	8,277	.65	6W2
Ghx	Guy Hill Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase, Terric Fibric Mesisol	3,476	.27	7WF
Hb	Homebrook	Clay		Well	Orthic Dark Gray	2,863	.22	3a
Hl	Halcrow	Organic		Very poor	Terric Mesisol sphagnic phase	5,907	.46	7W2
Ho	Homestead	Loam to clay loam		Imperfect	Gleyed Cumulic Regosol	1,103	.09	3b
Hrx	Horseshoe Island Complex	Coarse sand and gravel		Imperfect	Gleyed Eluviated Eutric Brunisol, Gleyed Gray Luvisol	3,544	.27	5MW
Hw	Howell	Organic		Very poor	Terric Mesisol, sphagnic phase	9,756	.76	7W2
In	Inwood	Loam to clay loam		Imperfect	Gleyed Gray Luvisol	281	.02	4L2
Kc	Kircro	Organic		Very poor	Terric Mesisol	15,515	1.21	7W2
Ki	Kinwow	Clay		Well	Orthic Gray Luvisol	1,395	.11	3a
Ko	Koostatak	Clay		Poor	Rego Humic Gleysol	1,528	.12	6W1
Ko(P)	Koostatak	Clay	Peaty	Poor	Rego Humic Gleysol	3,088	.24	6W1
Kt	Katimik	Organic		Very poor	Typic Mesisol, sphagnic phase	16,475	1.29	7W2

TABLE 58 (Continued)

Soil Symbol	Soil Name	Surface Texture	Phase	Drainage	Subgroup	Total Extent (hectares)	% of Area	Forest Capability
Kx	Kilkenny Complex	Organic		very poor	Terric Mesic Fibrisol, Terric Fibric Mesisol, Terric Fibrisol	10,686	.84	7WF
Li	Limestone Point	Loam to clay loam	Shallow and very shallow lithic	Well	Eluviated Eutric Brunisol	20,422	1.60	5LR
Li(s)	Limestone Point	Loam to clay loam	Extremely shallow lithic	Well	Eluviated Eutric Brunisol	14,286	1.12	6LR
Llx	Lamb Lake Complex	Organic		Very poor	Terric Mesisol sphagnic phase, Terric Mesisol, Terric Fibric Mesisol, Terric Mesic Fibrisol	35,422	2.77	7WF
Lp	Le Pas	Clay	Carbonated	Poor	Rego Gleysol	8,909	.70	7W1
Lt	Lettonia	Clay		Well	Solonetzic Gray Luvisol	158	.01	4D
Mg	Mantagao	Clay		Imperfect	Gleyed Gray Luvisol	4,893	.38	4W1
Mh	Marsh			Very poor	Rego Gleysol	15,931	1.25	7W1
Ml	Meleb	Loam to clay loam	Carbonated	Poor	Rego Humic Gleysol	275	.02	6W1
Ml(P)	Meleb	Loam to clay loam	Carbonated Peaty	Poor	Rego Humic Gleysol	8,713	.68	6W1
Mu	Mukatawa	Clay		Imperfect	Gleyed Solonetzic Gray Luvisol	546	.04	4W1
Mx	Molson Complex	Organic		Very poor	Terric Mesic Fibrisol, Terric Fibric Mesisol, Terric Fibrisol	51,560	4.03	7WF
N	Nels	Fine sandy loam to loam		Imperfect	Gleyed Cumulic Regosol	19,364	1.51	3b
Nb(P)	Napanee Bay	Clay	Peaty	Poor	Rego Humic Gleysol	356	.03	6W1
Nlx	Nekik Lake Complex	Organic		Very poor	Mesic Organic Cryosol, Fibric Organic Cryosol	913	.07	7K
No	Novra	Loam to clay loam		Poor	Rego Gleysol	1,276	.10	7W1
No(P)	Novra	Loam to clay loam	Peaty	Poor	Rego Gleysol	1,874	.15	7W1
Nr	Norris	Coarse sand to gravel	Carbonated	Poor	Rego Gleysol	3,161	.25	6W1
Nr(P)	Norris	Coarse sand to gravel	Carbonated Peaty	Poor	Rego Gleysol	7,622	.60	6W1
Orx	Orok Complex	Organic		Very poor	Terric Mesisol sphagnic phase, Terric Mesisol, Terric Fibric Mesisol, Terric Mesic Fibrisol	12,059	.94	7WF
Ox	Okno Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase, Terric Fibric Mesisol	10,001	.78	6W2
Ov	Overflowing	Organic		Very poor	Typic Mesisol aquic phase	11,597	.91	7W2
P	Pasquia	Fine sandy loam to loam	Carbonated	Poor	Rego Gleysol	6,075	.48	7W2
P(d)	Pasquia	Fine sandy loam to loam	Carbonated Drained	Poor	Rego Gleysol	1,052	.08	4W2
P(P)	Pasquia	Fine sandy loam to loam	Carbonated Peaty	Poor	Rego Gleysol	7,839	.61	7W1
Rex	Reed Lake Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase	669	.05	7W2
Rlx	Rock Island Complex	Organic		Very poor	Typic Mesisol, Typic Mesisol sphagnic phase	1,115	.09	7W2
Rrx	Rat River Complex	Organic		Very poor	Terric Mesisol, Terric Mesisol sphagnic phase, Terric Fibric Mesisol	8,096	.63	6W2
Sb	Sand beaches	Sand		Well to Imperfect	Regosol	265	.02	7U
Sd	Stead	Organic		Very poor	Typic Mesisol	34,628	2.71	7W2
Sf	Swanford	Loam		Imperfect	Gleyed Rego Black	521	.04	3c
Sfx	Saline flats		Saline	Poor	Rego Gleysol	350	.03	7N
Sm(P)	Sagemace	Clay	Peaty	Poor	Rego Humic Gleysol	5,441	.43	6W1
Sox	Soul Lake Complex	Coarse sand and gravel		Well	Eluviated Eutric Brunisol, Orthic Gray Luvisol, Orthic Eutric Brunisol	1,936	.15	5M

TABLE 58 (Continued)

Soil Symbol	Soil Name	Surface Texture	Phase	Drainage	Subgroup	Total Extent (hectares)	% of Area	Forest Capability
Srx	Sand River Complex	Organic		Very poor	Terric Mesic Fibrisol, Terric Fibric Mesisol, Terric Fibrisol	11,387	.89	7WF
Tux	Tremauden Complex	Coarse sand and gravel		Imperfect	Gleyed Eluviated Eutric Brunisol, Gleyed Gray Luvisol	2,694	.21	5MW
Whx	Whithorn Complex	Organic		Very poor	Mesic Fibrisol, Typic Fibrisol, Fibric Mesisol	18,470	1.44	7WF
Wr	Warpath	Clay		Imperfect	Gleyed Gray Luvisol	12,812	1.00	4W1
Wsx	Waskwei Complex	Organic		Very poor	Typic Mesisol, sphagnic phase, Typic Mesisol	6,565	.51	6W2
Wy	Westray	Loam to clay loam		Well	Orthic Gray Luvisol	1,075	.08	4L1

Subclass 3b Soils in this subclass are developed on imperfectly drained moderately to strongly calcareous, loamy alluvial sediments. Good mixed hardwood stands of balsam poplar, elm, green ash, box-elder and white birch can be grown on these soils. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
C	Carrot	10 810	.85
Ho	Homestead	1 103	.09
N	Nels	19 364	1.51
	Total	31 277	2.45

Subclass 3c Soils in this subclass are developed on imperfectly drained, strongly calcareous, loamy lacustrine sediments. Most sites support fairly good stands of aspen and balsam poplar. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Dv	Duck River	2 886	.23
Sf	Swanford	521	.04
	Total	3 407	.27
	Total Class 3	63 287	4.96

Class 4

Lands in this class have moderately severe limitations to the growth of commercial forests. Soils have level to gently sloping relief and are poorly to well drained. Conditions due to slight excess or lack of soil moisture, dense soil layers, insufficient nutrient supply or regional plant succession limit tree growth. Productivity is between 3.6 and 4.9 cubic metres per hectare per year.

Subclass 4L1 The soils in this subclass are developed on extremely calcareous loam till and are well drained. Growing season soil moisture deficiency and nutritional problems related to high carbonate levels of these soils seriously limit tree growth. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
At	Atikameg	17 925	1.40
Fd	Fairford	1 497	.12
Wy	Westray	1 073	.08
	Total	20 495	1.60

Subclass 4L2 The soils in this subclass are developed on imperfectly drained, extremely calcareous loam textured till. The soils of this subclass are suited to white spruce and trembling aspen. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Ci	Chitek	48 425	3.79
In	Inwood	281	.02
	Total	48 706	3.81

Subclass 4D The soils in this subclass are developed on well drained lacustrine clay. The dense B horizon can limit root development and reduce tree growth. These soils are suited to white spruce, trembling aspen and jack pine. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Lt	Lettonia	158	.01

Subclass 4W1 The soils in this subclass are developed on moderately to strongly calcareous, imperfectly drained lacustrine clay to clay till. Slight seasonal excess of soil moisture limits tree growth. Black spruce, aspen and balsam poplar are suited to these soils.

The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Mg	Mantagao	4 893	.38
Mu	Mukatawa	546	.04
Wr	Warpath	12 812	1.00
	Total	18 251	1.42

Subclass 4W2 The soils in this subclass are developed on moderately calcareous, poorly drained, loamy to clayey recent alluvium. These soils have been drained, and therefore have a better capability. Slight seasonal excess of soil moisture limits tree growth. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
B(d)	Big Lake, drained phase	410	.03
Be(d)	Big Eddy, drained phase	571	.04
P(d)	Pasquia, drained phase	1 052	.08
	Total	2 033	.15
	Total Class 4	89 643	6.99

Class 5

Lands in this class have severe limitations to the growth of commercial forests, soils may have level to gently sloping and low ridge and swale topography and are well to poorly drained. Serious limitations to tree growth are imposed by low nutrient levels of the soil and seasonal lack or excess of soil moisture. The productivity is usually between 2.2 and 3.5 cubic metres per hectare per year.

Subclass 5LR The soils in this subclass are developed on extremely calcareous, well to imperfectly drained, shallow loamy till over bedrock. Serious limitations to tree growth are imposed by low nutrient levels related to high carbonate levels of the soils and the shallow depth of the soils to bedrock. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Li	Limestone Point	20 422	1.60
Bc	Birch Bay	1 792	.14
	Total	22 214	1.74

Subclass 5M Soils in this subclass are developed on well to rapidly rained, strongly calcareous sand and gravel, beach ridges. Lack of soil moisture holding capacity limits tree growth. These areas are well suited for jack pine and white spruce. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Fx	Freshford complex	4 498	.35
Sox	Soul Lake complex	1 936	.15
	Total	6 434	.50

Subclass 5MW Soils in this subclass are developed on imperfectly drained, strongly calcareous sand and gravel, beach ridges. Seasonal patterns of soil moisture excess and deficit combine to limit tree growth. Jack pine and black spruce are found on these sites. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Hrx	Horseshoe Island complex	3 544	.27
Tux	Tremauden complex	2 694	.21
	Total	6 238	.48
	Total Class 5	34 886	2.72

Class 6

Lands in this class have severe limitations to the growth of commercial forests which are imposed by low fertility related to high acidity, or soils that are shallow to bedrock or that have problems related to poor drainage. Productivity is between 0.8 and 2.1 cubic metres per hectare per year.

Subclass 6LR Soils in this subclass are developed on very thin deposits of extremely calcareous loam till underlain by limestone bedrock. They are well drained and tree growth is limited by seasonal soil water deficit and nutritional problems related to high carbonate levels of the soil. Stunted jack pine grow on these sites. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Li(s)	Limestone Point, shallow phase	14 286	1.12

Subclass 6W1 Soils in this subclass are developed on poorly to very poorly drained gravel to clay materials. Tree growth is prevented by excessive soil moisture. Black spruce are found on these sites. Upon draining of these sites most of these soils capability would increase one class. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
As	Askandigau	3 089	.24
As(P)	Askandigau, peaty phase	8 627	.67

Dr	Dering	17 044	1.33
Dr(P)	Dering, peaty phase	43 381	3.39
Ea(P)	Easterville, peaty phase	1 296	.10
Ko	Koostatak	1 528	.12
Ko(P)	Koostatak, peaty phase	3 088	.24
Ml	Meleb	275	.02
Ml(P)	Meleb, peaty phase	8 713	.68
Nb(P)	Napanee Bay, peaty phase	356	.03
Nr	Norris	3 161	.25
Nr(P)	Norris, peaty phase	7 622	.60
Sm(P)	Sagemace, peaty phase	5 441	.43
	Total	103 621	8.10

Subclass 6W2 The soils in this subclass are developed on poorly to very poorly drained mesic forest peat deposits, where the permanent water table is near the surface. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Gdx	Grindstone complex	8 277	.65
Ox	Okno complex	10 001	.78
Rrx	Rat River complex	8 096	.63
Wsx	Waskwei complex	6 565	.51
	Total	32 939	2.57
	Total Class 6	150 846	11.79

Class 7

Lands in this class have very severe limitations that preclude the growth of commercial forests because of excess wetness, periodic inundation, exposure, excessive salinity, lack of rooting zone over bedrock, or lack of soil moisture. Productivity is less than 0.8 cubic metres per hectare per year.

Subclass 7MR The soils in this subclass developed on gently sloping limestone bedrock. The lack of unconsolidated mineral materials make these lands extremely dry. Tree growth is very severely limited by lack of moisture and lack of rooting medium. Scattered jack pine grow in organic and mineral debris-filled cracks and crevasses on these rocks. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
cR	carbonate rock	5 430	.42

Subclass 7N Soils in this subclass are developed on imperfectly to poorly drained loam textured materials. Tree growth is prevented by a high level of soluable salts in the soil. These soils are:

		Extent (ha)	*% of Map Area*
Sfx	Saline Flats complex	350	.03

Subclass 7U Soils in this subgroup developed on active lake beaches. Exposure to wind and the abrasive action of sand inhibit tree growth. These soils are:

		Extent (ha)	*% of Map Area*
Sb	Sand beaches	265	.02

Subclass 7W1 Soils in this subclass developed on poorly to very poorly drained sand to clay materials. Tree growth is prevented by excessive soil moisture. If these soils were drained their capability would be 4W. These soils are:

		Extent (ha)	*% of Map Area*
B	Big Lake	16 197	1.27
B(P)	Big Lake, peaty phase	22 637	1.77
Fo	Foley	521	.04
Fo(P)	Foley, peaty phase	768	.06
P	Pasquia	6 075	.48
P(P)	Pasquia, peaty phase	7 839	.61
Lp	Le Pas	8 909	.70
No	Novra	1 276	.10
No(P)	Novra, peaty phase	1 874	.15
	Total	66 196	5.18

Subclass 7W2 The soils in this subclass developed on level, poorly or very poorly drained mesic sedge peat deposits, where the permanent water table is very near to the surface. Excess wetness precludes tree growth. The soils in this subclass are:

		Extent (ha)	*% of Map Area*
Ca	Cayer	107 768	8.43
Cr	Crane	15 246	1.19
Hl	Halcrow	5 907	.46
Hw	Howell	9 756	.76
Kc	Kircro	15 515	1.21
Kt	Katimik	16 475	1.29
Ov	Overflowing	11 597	.91
Rex	Reed Lake	669	.05
RIx	Rock Island	1 115	.09
Sd	Stead	34 628	2.71
	Total	218 676	17.10

Subclass 7WI The soils in this subclass developed on level areas of loamy materials where the permanent water table is near the surface. The excess moisture and frequent flooding inhibits tree growth. The soils in this subclass are:

		Extent (ha)	% of Map Area
Mh	Marsh	15 931	1.25

Subclass 7WF The soils in this subclass are developed on level, poorly or very poorly drained fibric sphagnum moss peat deposits. The growth is very severely limited by excess of soil moisture and low natural fertility, allowing only the growth of stunted black spruce and some tamarack. The soils are:

		Extent (ha)	% of Map Area
Chx	Chocolate complex	1 015	.08
Cp	Catfish Point	1 210	.09
Ghx	Guy Hill complex	3 476	.27
Kx	Kilkenny complex	10 686	.84
Llx	Lamb Lake complex	35 422	2.77
Mx	Molson complex	51 560	4.03
Orx	Orok complex	12 059	.94
Srx	Sand River complex	11 387	.89
Whx	Whithorn complex	18 470	1.44
	Total	145 285	11.35

Subclass 7K The soils in this subclass are developed on level, domed or ridged peat plateaus, which are deep perennially frozen forest peat. The growth is very severely limited by the drier raised site, and the frozen subsoil. Very stunted black spruce are found on these sites. The soils are:

		Extent (ha)	% of Map Area
Nlx	Nekik Lake complex	913	.07
	Total Class 7	453 046	35.42

TABLE 59
Summary of Forest Capability Classes in The Pas Map Area

Capability Class	Extent(ha)	% of Map Area
1	-	-
2	-	-
3	63 287	4.96
4	89 643	6.99
5	34 886	2.72
6	150 846	11.79
7	453 046	35.42
Total surveyed land	791 708	61.88
Water bodies	430 480	33.72
Pasquia Settlement	56 288	4.40
Total	1 278 476	100.00

ENGINEERING

Engineering Uses of the Soils

This section provides information for use by engineers and land use planners concerned with engineering and related geotechnical aspects of soil. It is intended to supplement the information in the soil report and on the soil map with additional data on engineering properties of soils.

Soil properties considered highly important in engineering are permeability, strength, compaction and drainage characteristics, shrink-swell potential, grain size, plasticity and reaction (pH). Also important are depth to the water table, depth to bedrock and slope. Various combinations of these properties affect to varying degrees, the construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds, small dams and systems for disposal of sewage and refuse.

The criteria used to evaluate soil suitability for selected engineering uses are adopted from guides found in Coen et al[24], and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[25] and the Canada Soil Survey Committee[26].

Most of the information in this section is presented in Tables 60, 61 and 63. Engineering test data determined for a few soils in The Pas area are included in Table 60. Engineering description of the soils and their estimated properties significant to engineering are provided in Table 61. These data, in addition to information contained in other sections of the report have been used to rate the soils according to their suitability for ten selected engineering uses in Table 63. When using these interpretations consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each of Tables 65 through 78 (Appendix D). When conditions of use and management are not the same as those defined here, new guides should be established and appropriate revisions made in Table 63.

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.

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[24] Coen et al, 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37. 208pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[25] USDA, 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service USDA. SCS-45. 87pp.

[26] CSSC, 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357pp.

TABLE 60
Engineering Test Data for Selected Soils in The Pas Area

Map Symbol	Series Name & Location	Horizon	Depth (cm)	Percent Passing Sieve No.4 4.7 mm	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 .074 mm	Percent smaller than .05 mm	.002 mm	Liquid Limit	Plastic Index	Shrinkage Limit %	Ratio	Lineal %	Sat. %	USDA	AASHO	Unified
Wr	Warpath (NW36-57-25W)	Ckgl	20-55		95	92	87	84	54	43	21	14	1.9	22	71	C	A-7-6(19)	CL
		Ckg2	55-100		99	98	95	94	77	54	27	21	1.7	22	85	C	A-7-6(30)	CH
Ki	Kinwow (SE1-58-24W)	Ckgl	15-68		100	99	98	98	80	58	28	18	1.8	25	93	C	A-7-6(33)	CH
		IICkgl	68 +		82	74	61	55	13	15	2	14	2.0	9	51	SIL	A-4(0)	ML
Mg	Mantagao (SE1-49-25W)	Ckgl	28-75		95	90	81	77	29	28	11	17	1.9	15	49	SICL	A-6(7)	CL
		IICkgl	75 +		83	75	64	59	12	16	2	15	2.0	8	50	SIL	A-4(0)	ML
Cl	Cedar Lake (SE-29-48-25W)	Ck1	15-45		96	93	88	87	42	42	20	17	2.0	21	71	SIC	A-7-6(18)	CL
		Ck2	45-120		98	96	91	88	39	34	17	16	1.9	19	61	SIC-SICL	A-6(15)	CL
		Ck3	120 +		97	90	81	76	25	24	8	14	2.0	16	50	SIL	A-4(4)	CL
Cl	Cedar Lake (SE11-57-26W)	Ck1	18-30		90	85	78	75	37	38	17	16	1.9	20	66	SIC	A-6(13)	CL
		Ck2	30-80		96	90	85	84	54	41	20	17	1.9	20	68	C	A-7-6(17)	CL
		Ck3	80 +		95	90	84	81	49	41	20	16	1.8	22	75	C	A-7-6(17)	CL

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify soil limitations. The use of soils rated as poor depends on the nature of the limitations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for onsite evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of onsite studies depends on the use to be made of the soil and the kinds of soil problems involved.

Engineering Test Data

Engineering test data determined on a few soils of The Pas map area are presented in Table 60. These data, in addition to information contained in other sections of the report and experience with the same kinds of soil in other parts of Manitoba have been used as a general guide to estimate the engineering properties for the soils mapped in the The Pas area (Table 61).

The engineering classifications in Table 63, are based on particle size distribution data obtained by mechanical analysis and from tests to determine the liquid and plastic limits. The mechanical analysis was made by combined sieve and pipette analysis on the soil material passing the No. 10 sieve (2.0mm). The terminology used to describe soil properties measured in Table 63 are defined in the Glossary and discussed in greater detail in the PCA Soil Primer[27].

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[27] Portland Cement Association 1973 PCA Soil Primer 40pp., Illust., Old Orchard Road, Skokie, Illinois 60076.

Engineering Description of Soils

Engineering properties have been estimated for the soils in The Pas map area (Table 61). Each soil and map symbol is listed and estimates of various physical and chemical properties are given. These estimates are based on the soil test data in Table 60 and on information contained in other sections of the report. In general, the information in this table applies to a depth of 1.5 to 2.0 m or less. Depth from the surface is given for major horizons or a sequence of horizons if they have similar engineering properties. Other horizons or discontinuities in parent material are indicated if they have properties significantly different from adjacent horizons. Because the properties estimated in Table 61, are for a typical profile, some variation from the values given should be expected.

Particle size distribution for each important soil layer is listed according to the U.S. Department of Agriculture textural classification, the AASHO and Unified engineering classifications. The columns headed "Percentage passing Sieve" list the percentage of material that passes the No. 4, No. 40 and No. 200 sieves. Material passing the No. 200 sieve approximates the amount of silt and clay in a soil.

Permeability of the soil as it occurs in place is estimated. The estimates are based on texture, structure and consistence of the soils and expressed in cm/hr.

Reaction (pH) of the soil materials is estimated from analysis of selected profiles and parent materials in the map area.

Sulphate hazard is estimated from measurements of electrical conductivity and soluble salt analysis on selected soil samples. Only a few soils contain high concentrations of soluble salts. In these situations, usually one-half or more of the salts are sulphates. The presence and quantity of sulphate salts in the soil affects concrete stability.

The shrink-swell potential is an indication of the volume change to be expected of the soil material with change in moisture content. It is estimated on the basis of the amount of clay with high shrink-swell properties in the soil layers. Generally, soils classified as A-7 and CH have high shrink-swell potential. Clean sands and gravels and those having a small amount of nonplastic to slightly plastic fines have low shrink-swell potential.

Suitability of soils for selected engineering uses

The suitability ratings in Table 63, are based on engineering test data from the map area (Table 60) and on the estimated engineering properties presented in Table 61. The four classes used to summarize the suitability of the soils for selected engineering uses are defined in the following section. The same four suitability classes are also used to evaluate each soil for recreation uses.

Definition of Soil Suitability Classes

Evaluation of soil suitability for both engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soil series which are employed to describe mapping units. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long-term effects of the potential use on the behaviour of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

Good	Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.
Fair	Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.
Poor	Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require either the removal of the limitation or difficult and costly alteration of the soil or special engineering design or intensive maintenance to overcome the limitation.
Very poor	Soils have one or more features so unfavourable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

Soil Suitability Subclasses

The basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering and recreation uses are in Table 62. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

TABLE 61
Engineering Descriptions of the Soils and Their Estimated Properties Significant to Engineering

Map Symbol	Soil Series	Depth (cm)	Classification			% Passing			Perme-ability (cm/hr)	Reaction	Sulfate Hazard	Dis-persion	Shrink-Swell	Depth to Water Table
			USDA	Unified	AASHO	No. 10 (2.0) mm	No. 40 (0.42) mm	No. 200 (.074) mm						
As	Askandigau	0-50	C	CH	A-7-6	100	100	95-100	0.05-0.13	7.0-7.5	low	low	high	0-.05 m
		50-100	C	CH	A-7-6	100	100	95-100	0.05-0.13	7.5-8.0	mod.	low	high	
AsP	Askandigau peaty phase	25-0	Mesic Peat	Pt	—	—	—	—	—	6.5-7.0	low	—	—	at or near surface
		0-100	C	CH	A-7-6	100	100	95-100	0.05-0.13	7.5-8.0	mod.	low	high	
At	Atikameg	0-20	L	ML	A-4	100	90-100	70-90	1.5-5.0	6.5-7.0	none	low	mod.	1 m
		20-100	SiL	ML	A-4	100	90-100	70-90	1.5-2.5	7.5-8.0	low	low	mod.	
B	Big Lake	0-30	VFSL-SiCL	ML-CL	A-4 to A-6	75-90	50-85	35-70	0.5-1.5	7.5-8.5	mod.	low	mod.	.5-1.0 m
		30-100	VFSL-SiCl	ML-CL	A-4 to A-6	75-90	50-85	35-70	0.5-1.5	7.5-8.5	mod.	low	mod.	
B(d)	Big Lake drained phase	0-20	VFSL-SiCL	ML-CL	A-4 to A-6	75-90	50-85	35-70	0.5-1.5	7.5-8.5	mod.	low	mod.	1 m
		20-100	VFSL-SiCL	ML-CL	A-4 to A-6	75-90	50-85	35-70	0.5-1.5	7.5-8.5	mod.	low	mod.	
B(P)	Big Lake peaty phase	30-0	Mesic Peat	Pt	—	—	—	—	—	6.0-7.0	—	—	—	at or near surface
		0-20	VFSL-SiCL	ML-CL	A-4 to A-6	75-90	50-85	35-70	0.5-1.5	7.5-8.5	mod.	low	mod.	
		20-100	VFSL-SiCL	ML-CL	A-4-A-6	75-90	50-85	35-70	0.5-1.5	7.5-8.5	mod.	low	mod.	
Bc	Birch Bay loam	0-30	L-CL	CL-ML	A-4 to A-6	90-100	70-90	50-70	1.3-5.08	7.0-7.5	none	low	mod.	.5 m
		30-60	L-CL	CL-ML	A-4 to A-6	90-100	70-90	50-70	0.8-3.8	7.5-8.0	mod.	low	mod.	
		60 +	Rock	—	—	—	—	—	—	—	—	—	—	—
Be(d)	Big Eddy	0-50	C	CH	A-7-6	100	100	95-100	0.05-0.13	8.0-8.5	mod.	low	high	1.0 m
		50-100	SiL	ML	A-4	100	90-100	70-90	1.5-2.5	8.0-8.5	mod.	low	mod.	
C	Carrot	0-100	SiL	ML	A-4	100	90-100	70-90	1.5-2.5	8.0-8.5	mod.	low	mod.	.5-1.0 m
Ca	Cayer	0-40	Mesic Peat	Pt	—	—	—	—	—	6.0-7.0	—	—	—	at surface
		40 +	L-CL Till	ML-CH	A-4 to A-7-6	100	100	70-90	0.1-5.0	7.5-8.0	none	low	mod. to high	
Chx	Chocolate complex	0-120	Fibric Peat	Pt	—	—	—	—	—	4.5-5.0	—	—	—	at or near surface
		120-145	Mesic Peat	Pt	—	—	—	—	—	5.0-6.0	—	—	—	
		145 +	L-C	ML-CH	A-4 to A-7-6	100	100	70-90	0.13	7.0-8.0	low	low	mod. high	
Ci	Chitek	0-13	L	CL-ML	A-4	90-100	80-90	50-70	1.5-5.0	6.5-7.0	none	low	mod.	.5-1.0
		13-90	L-CL	CL-ML	A-4	80-90	70-80	50-70	1.5-2.5	7.5-8.0	none	low	mod.	
Cl	Cedar Lake	0-7	C	CH	A-7-6	100	95-100	90-95	0.05	7.0-7.5	none	low	high	1 m
		7-120	SiC	CH	A-7-6	100	95-100	90-95	0.05	7.0-8.0	low	low	high	
		pockets	SiL	ML	A-4	100	90-100	70-90	1.5-2.5	7.5-8.0	low	low	mod.	

Cp	Catfish Point	0-60	Fibric Peat	Pt	—	—	—	—	—	3.5-5.0	low	low	low	at or near
		60-100	Mesic Peat	Pt	—	—	—	—	—	5.0-6.5	low	low	low	surface
		100 +	S-Gr	GW-GP	GW-GP	A-1	30-50	0-10	25.0 +	7.0-8.0	low	low	low	
Cr	Crane	0-40	Mesic Peat	Pt	—	—	—	—	—	—	—	—	—	at surface
		40 +	SiL Till	CL	A-4	90-100	70-80	50-70	1.5-2.5	7.5-8.0	none	none	mod.	
Dp	Davis Point	0-13	C	CH-MH	A-7-6	100	100	85-95	.1-1.5	6.5-7.0	none	none	high	.5-1.0 m
		13-40	C	CH-MH	A-7-6	100	100	85-95	.1-1.5	6.5-7.0	none	none	high	
		40-90	C	CH-MH	A-7-6	100	100	85-95	.1-1.5	7.0-7.5	low	none	high	
		pockets	SiL	ML	A-4	100	90-100	70-90	1.5-2.5	8.0-8.5	low	none	mod.	
Dr	Dering	0-15	L	ML	A-4	100	90-100	70-90	1.5-2.5	7.5-8.0	low	none	mod.	0-0.5 m
		15-100	SiL	ML	A-4	100	90-100	70-90	1.5-2.5	8.0-8.5	low	none	mod.	
Dr(P)	Dering	25-0	Music Peat	Pt	—	—	—	—	—	6.5-7.0	—	—	—	at or near
	peaty phase	0-20	L	ML	A-4	100	90-100	70-90	1.5-2.5	7.5-8.0	low	none	mod.	surface
		20-100	SiL	ML	A-4	100	90-100	70-90	1.5-2.5	8.0-8.5	low	none	mod.	
Dv	Duck River	0-20	L	ML	A-4	100	90-100	70-90	2.0-5.0	7.0-7.5	low	none	mod.	.5-1.0 m
		20-100	SiL	ML	A-4	100	90-100	70-90	2.0-3.0	7.5-8.0	mod.	none	mod.	
Ea(P)	Easterville	25-0	Mesic Peat	Pt	—	—	—	—	—	6.5-7.0	—	—	—	at or near
		0-50	S-Gr	SP, SW, GP	—	—	—	—	—	7.5-8.0	low	low	low	surface
		50-100	SiL	ML	A-4	100	70-90	50-70	1.5-2.5	7.5-8.0	low	low	mod.	
Ei	Egg Island	0-40	C	CH-MH	A-7-6	100	100	100	.1-1.5	6.5-7.0	low	low	high	1 m
		40-85	SiL	ML	A-4	100	70-90	50-70	1.5-2.5	8.0-8.5	low	low	mod.	
		85-100	Rock	—	—	—	—	—	—	—	—	—	—	
Fd	Fairford	0-13	L	ML	A-4	70-85	60-80	50-70	1.5-2.5	7.0-8.0	low	low	mod.	0.5-1 m
		13-90	SiL	ML	A-4	70-85	60-80	45-65	1.5-2.5	8.0-8.5	low	low	mod.	
Fo	Foley	0-50	L	ML	A-4	100	90-100	70-90	2.0-5.0	7.0-7.5	low	none	mod.	.5-1.0 m
		50-100	SiL	ML	A-4	100	90-100	70-90	2.0-3.0	7.5-8.0	mod.	none	mod.	
Fo(P)	Foley	30-0	Mesic Peat	Pt	—	—	—	—	—	6.5-7.0	—	—	—	at or near
	peaty phase	0-50	L	ML	A-4	100	90-100	70-90	2.0-3.0	7.5-8.0	mod.	none	mod.	surface
Fx	Freshford	0-30	LS-SL	SP-GP	A-1	30-70	20-30	0-15	25.0 +	6.5-7.0	none	low	low	1.5 m
	complex	30 +	S-Gr	GW-GP	A-1	30-50	30-50	0-10	25.0 +	7.5-8.0	none	low	low	
Gdx	Grindstone	0-45	Fibric Peat	Pt	—	—	—	—	—	4.0-5.5	—	—	—	at or near
	complex	45-120	Mesic Peat	Pt	—	—	—	—	—	5.0-6.5	—	—	—	surface
		120 +	SiL	ML	A-4	70-85	60-80	45-65	1.5-2.5	8.0-8.5	low	low	mod.	
Ghx	Guy Hill	0-45	Fibric Peat	Pt	—	—	—	—	—	4.5-5.5	—	—	—	at or near
	complex	45-115	Mesic Peat	Pt	—	—	—	—	—	5.5-6.5	—	—	—	surface
		115 +	S-Gr	SP, SW, GP	A-1	30-70	20-30	0-10	25.0 +	7.0-7.5	low	low	low	
Hb	Homebrook	0-13	C	CH-MH	A-7-6	100	95-100	90-95	0.1	7.0-7.5	none	low	high	
		13-40	C	CH-MH	A-7-6	100	95-100	90-95	0.1	7.0-7.5	none	low	high	
		40-90	C	CH-MH	A-7-6	100	95-100	90-95	0.1	7.5-8.0	none	low	high	
Hl	Halcrow	0-60	Fibric Peat	Pt	—	—	—	—	—	4.5-5.5	—	—	—	at or near
		60-140	Mesic Peat	Pt	—	—	—	—	—	5.5-6.5	—	—	—	surface
		140 +	SiL	ML	A-4	70-85	60-80	45-65	1.5-2.5	7.0-8.0	none	low	mod.	

TABLE 61 (Continued)

Map Symbol	Soil Series	Depth (cm)	Classification			% Passing			Permeability (cm/hr)	Reaction	Sulfate Hazard	Dispersion	Shrink-Swell	Depth to Water Table
			USDA	Unified	AASHO	No. 10 (2.0) mm	No. 40 (0.42) mm	No. 200 (.074)						
Ho	Homestead	0-20	SiL	ML	A-4	95-100	90-100	50-75	2.5-5.0	7.5-8.0	low	low	mod.	.5 m
		20-60	L	ML	A-4	95-100	90-100	60-75	2.5-5.0	7.5-8.5	low	low	mod.	
		60-100	LVFS	SM	A-2-4	90-100	60-75	20-40	5.0-7.0	7.5-8.5	mod.	low	low	
Hrx	Horseshoe Island complex	0-65	S-Gr	SP, SW, GP	A-1	30-70	20-30	0-10	25.0 +	7.0-7.5	none	low	low	0.5-1 m
		65-100	SiL	ML	A-4	70-85	60-80	45-65	1.5-2.5	7.0-8.0	none	low	mod.	
Hw	Howell	0-55	Fibric Peat	Pt	–	–	–	–	–	4.5-5.5	–	–	–	at or near surface
		55-135	Mesic Peat	Pt	–	–	–	–	–	5.5-6.5	–	–	–	
		135 +	L-C	ML-CH	A-4-A-7-6	100	100	70-90	0.1-5.0	7.0-8.0	none	low	mod.	
In	Inwood	0-20	L-SiL	CL	A-6	90-100	80-90	60-80	1.5-5.0	7.0-7.5	none	low	mod.	.5-1.0 m
		20-90	L-SiL	ML	A-4	90-100	80-90	60-80	1.5-2.5	7.5-8.0	none	low	mod.	
Kc	Kircro	0-115	Mesic Peat	Pt	–	–	–	–	–	6.0-7.0	–	–	–	at or near surface
		115 +	Sand	SP	A-3	100	90-100	10-20	15-25	7.5-8.0	none	low	low	
Ki	Kinwow	0-45	C	MH-CH	A-7-5	100	100	100	0.13	6.5-7.5	–	–	–	–
		45-75	C	CH	A-7-6	100	100	100	0.13	7.0-7.5	–	–	–	–
		75 +	L	ML-CL	A-4	75-90	50-85	35-70	1.5-2.5	7.5-8.0	–	–	–	–
Ko	Koostatak	0-60	C	CH	A-7-6	100	100	95-100	0.05-0.13	7.0-7.5	low	low	high	near surface
		60-100	C	CH	A-7-6	100	100	95-100	0.02-0.08	7.5-8.0	mod.	low	high	
Ko(P)	Koostatak peaty phase	0-30	Mesic Peat	Pt	–	–	–	–	–	–	–	–	–	at surface
		30-130	Similar to Ko above											
Kt	Katimik	0-60	Fibric Peat	Pt	–	–	–	–	–	4.5-5.5	–	–	–	at the surface
		60-160	Mesic Peat	Pt	–	–	–	–	–	5.5-7.0	none	–	–	
		160 +	C	CH	A-7-6	100	100	95-100	0.05-0.08	7.5-8.0	low	low	high	
Kx	Kilkenny complex	0-125	Fibric Peat	Pt	–	–	–	–	–	4.5-5.0	–	–	–	at or near surface
		125-150	Mesic Peat	Pt	–	–	–	–	–	5.0-6.0	–	–	–	
		150	SiL	ML	A-4	90-100	80-90	60-80	1.5-2.5	7.5-8.0	low	low	mod.	
Li	Limestone Point	0-60	SiL	ML	A-4	90-100	80-90	60-80	1.5-2.5	7.5-8.0	low	low	mod.	1 m
		60-100	Rock	–	–	–	–	–	–	–	–	–	–	–
Li(s)	Limestone Point shallow phase	0-20	SiL	ML	A-4	90-100	80-90	60-80	1.5-2.5	7.5-8.0	low	low	low	1 m
		20 +	Rock	–	–	–	–	–	–	–	–	–	–	–
Llx	Lamb Lake	0-30	Fibric Peat	Pt	–	–	–	–	–	4.5-5.0	none	–	–	at the surface
		30-100	Mesic Peat	Pt	–	–	–	–	–	6.0-7.5	none	–	–	
		100 +	L-Sil	ML	A-4 to A-6	50-60	30-50	10-20	0.5-1.5	7.5-8.0	low	low	low	

Lp	Le Pas	0-30	SiC	CH	A-7-6	100	95-100	85-95	.1	6.5-7.5	low	low	high	0.5 m
		30-50	C	CH	A-7-6	100	95-100	85-95	.1	7.5-8.5	low	low	high	
		50-100	SiCL	CL	A-6	80-95	95-100	85-95	2.5	7.5-8.5	low	low	high	
Lt	Lettonia	0-60	C	CH	A-7-6	100	100	80-90	0.05-0.1	6.5-7.5	none	low	high	2 m
		60-100	C	CH	A-7-6	100	100	80-90	0.03-0.08	7.5-8.0	low	mod.	high	
Mg	Mantagao	0-70	C	CH	A-7-6	100	100	95-100	0.05-0.5	7.0-7.5	none	low	high	1 m
		70-120	L-SiL	ML	A-4	75-95	50-85	35-70	2.5-15.0	7.5-8.0	low	low	low to mod.	
Ml	Meleb	0-15	L-CL	ML-CL	A-4 to A-6	75-90	70-80	50-70	1.5-5.0	7.0-7.5	low	low	mod.	0.0.5 m
		15-100	SiL	ML	A-4	75-90	70-80	50-70	2.5-5.0	7.5-8.5	mod.	low	mod.	
Ml(P)	Meleb peaty phase	30-0	Mesic Peat	Pt	—	—	—	—	—	6.5-7.5	—	—	—	at surface
		0-20	L-CL	ML-CL	A-4 to A-6	75-90	70-80	50-70	1.5-2.5	7.5-8.5	low	low	mod.	
		20-100	SiL	ML	A-4	75-90	70-80	50-70	1.5-2.5	7.5-8.5	low	low	mod.	
Mu	Mukatawa	0-40	C	CH	A-7-6	100	100	80-90	0.05-0.1	6.5-7.0	none	low	high	1 m
		40-120	C	CH	A-7-6	100	100	80-100	0.05-0.1	7.5-8.0	low	low	high	
Mx	Molson complex	0-120	Fibric Peat	Pt	—	—	—	—	—	4.5-5.0	—	—	—	at or near surface
		120-145	Mesic Peat	Pt	—	—	—	—	—	5.0-6.0	—	—	—	
		145 +	SiL	ML	A-4	90-100	80-90	60-80	1.5-2.5	7.5-8.0	low	low	mod.	
N	Nels	0-20	SiL	ML	A-4	100	100	90-95	1.3-5.0	6.5-7.5	none	low	mod.	.5-1 m
		20-50	VFSL	ML	A-4	100	100	75-95	1.3-5.0	7.5-8.5	low	low	mod.	
		50-70	L	ML	A-4	100	100	90-95	1.3-5.0	7.5-8.5	low	low	mod.	
Nb(P)	Napanee Bay peaty phase	30-0	Mesic Peat	Pt	—	—	—	—	—	6.5-7.0	—	—	—	at surface
		0-50	C	CH	A-7-6	100	100	80-90	0.05-0.1	6.5-7.0	none	low	high	
		50-100	SiL	ML	A-4	90-100	80-90	60-80	0.5-1.0	7.5-8.0	low	low	mod.	
Nlx	Nekik Lake complex	0-30	Fibric Peat	Pt	—	—	—	—	—	5-6.0	—	—	—	above frozen humic layer
		30-50	Humic Peat	Pt	—	—	—	—	—	6.0-7.0	—	—	—	
No	Novra	0-30	SiL	ML	A-4	100	100	90-95	2.5-5.0	7.0-7.5	none	low	mod.	0-.5 m
		30-70	SiCL	CL	A-4 to A-7-6	100	100	90-95	2.5	7.0-8.0	low	low	mod.	
No(P)	Novra peaty phase	25-0	Mesic	Pt	—	—	—	—	—	6.0-7.0	—	—	—	at or near surface
		0-35	SiL	ML	A-4	100	100	90-95	2.5	7.0-8.0	low	low	mod.	
		35-65	SiCL	CL	A-4 to A-7-6	100	100	90-95	2.5	7.0-8.0	low	low	mod.	
Nr	Norris	0-30	LS-Grl	SP-GP	A-1	30-70	20-30	0-15	15.0-20.0 +	6.5-7.0	none	low	low	0-0.5 m
		30 +	S-Gr	GW-GP	A-1	30-50	30-50	0-10	25.0 +	7.5-8.0	none	low	low	
Nr(P)	Norris peaty phase	30-0	Mesic Peat	Pt	—	—	—	—	—	6.0-7.0	—	—	—	at or near surface
		0-30	LS-Grl	SP-GP	A-1	30-70	20-30	0-15	15.0-20.0	6.5-7.0	none	low	low	
		30 +	S-Gr	GW-GP	A-1	30-50	30-50	0-10	15.0 +	7.5-8.0	none	low	low	
Orx	Orok complex	0-60	Fibric Peat	Pt	—	—	—	—	—	4.5-5.0	low	low	—	at surface
		60-150	Mesic Peat	Pt	—	—	—	—	—	6.0-7.0	low	low	—	
		130 +	L-C	ML-CH	A-4 to A-7-6	100	100	70-90	0.13	7.5-8.0	low	low	mod. to high	

TABLE 61 (Continued)

Map Symbol	Soil Series	Depth (cm)	Classification			% Passing			Perme-ability (cm/hr)	Reaction	Sulfate Hazard	Dis-persion	Shrink-Swell	Depth to Water Table
			USDA	Unified	AASHO	No. 10 (2.0) mm	No. 40 (0.42) mm	No. 200 (.074)						
Ox	Okno complex	0-30	Fibric Peat	Pt	—	—	—	—	—	5.5-6.0	low	low	—	at surface
		30-120	Mesic Peat	Pt	—	—	—	—	—	6.0-7.0	low	low	—	
		120 +	L-C	ML-CH	A-4 to A-7-6	100	100	70-90	0.13	7.4-8.0	low	low	mod. to high	
Ov	Overflowing	0-25	Fibric Peat	Pt	—	—	—	—	—	6.0-7.0	low	low	—	at or near surface
		25-175	Mesic Peat	Pt	—	—	—	—	—	6.0-7.0	low	low	—	
		175 +	C	CH	A-7-6	100	100	95-100	0.05-0.10	7.0-8.0	low	low	high	
P	Pasquia	0-20	C	CH	A-7-6	100	100	95-100	.05-0.10	7.0-8.0	low	low	high	0-.5 m
		20-60	VFSL	ML	A-4	100	100	75-95	1.3-5.0	8.0-8.5	mod.	low	mod.	
P(d)	Pasquia drained phase	0-14	C	CH	A-7-6	100	100	95-100	.05-.10	7.0-8.0	low	low	high	1 m
		14-50	VFSL	ML	A-4	100	100	75-95	1.3-5.0	8.0-8.5	mod.	low	low	
P(P)	Pasquia peaty phase	30-0	Mesic Peat	Pt	—	—	—	—	—	6.0-7.0	—	—	—	at or near surface
		0-15	C	CH	A-7-6	100	100	95-100	.05-.10	7.0-8.0	low	low	high	
		15-45	VFSC	ML	A-4	100	100	75-95	1.3-5.0	8.0-8.5	mod.	low	low	
Rex	Reed Lake complex	0-20	Fibric Peat	Pt	—	—	—	—	—	6.0-7.0	low	—	—	at or near surface
		20-120	Mesic Peat	Pt	—	—	—	—	—	6.5-7.5	low	—	—	
		120 +	L-C	ML-CH	A-4 to A-7-6	100	100	70-90	0.3	7.5-8.0	low	low	mod. high	
Rlx	Rock Island complex	0-200	Mesic Peat	Pt	—	—	—	—	—	6.0-7.0	low	—	—	at or near surface
		200 +	C	CH	A-7-6	100	100	95-100	1.05-0.10	7.0-8.0	low	low	high	
Rrx	Rat River complex	0-75	Mesic peat	Pt	—	—	—	—	—	6.5-7.2	none	low	low	at surface
		75-95	LFS	SW to SP	A-2 to A-4	100	85-95	5-35	13-25 +	7.2-7.4	low	low	none	
		95 +	FS	SM to SP	A-2	100	85-95	3-15	13-25 +	7.4-7.8	low	low	none	
Sb	Sand Beach	0-100	S-Gr	SP, GP, GM or SM	A-1 to A-2	50-100	15-50	0-15	25.0 +	7.0-8.0	none	low	low	0-1 m
Sd	Stead	0-160	Mesic Peat	Pt	—	—	—	—	—	6.5-7.0	low	—	—	at surface
		160 +	L-C	ML to CH	A-4 to A-7	100	100	70-90	0.03	7.6-8.0	low	low	mod. to high	
Sf	Swanford	0-30	SiL	ML	A-4	100	100	90-95	1.3-5.0	6.5-7.5	none	low	mod.	.5-1 m
		30-70	VFSL	ML	A-4	100	100	75-95	1.2-5.0	7.5-8.5	low	low	mod.	
Sfx	Saline Flats complex	0-100	SiL	ML	A-4	90-100	80-90	60-80	0.5-1.0	7.5-8.0	very severe	high	mod.	0.0-0.5 m
Sm(P)	Sagemace peaty phase	30-0	Mesic Peat	Pt	—	—	—	—	—	—	—	—	—	at or near surface
		0-100	C	CH	A-7-6	100	100	95-100	0.05-0.13	7.5-8.0	mod.	low	high	

Sox	Soul Lake complex	0-60	Sand-CoGr	SP-GP	A-1	30-50	30-50	0-10	15.0-20.0	6.5-7.0	none	low	low	1 m
		60-100	SiL	ML	A-4	90-100	80-90	60-80	1.0-2.0	7.0-8.0	low	low	mod.	
Srx	Sand River complex	0-110	Fibric peat	Pt	—	—	—	—	—	4.5-5.0	—	—	—	at or near surface
		110-145	Mesic Peat	Pt	—	—	—	—	—	5.0-6.0	—	—	—	
		145 +	S-Gr	SP-GP	A-1	30-70	20-30	0-15	15.0-20.0	7.5-8.0	low	none	low	
Tux	Tremauden complex	0-50	S-CoGr	SP-GP	A-1	30-50	30-50	0-10	15.0-20.0	7.0-8.0	none	low	low	0-0.5 m
		50-100	Sil	ML	A-4	90-100	80-90	60-80	1.0-2.0	7.5-8.5	low	low	mod.	
Whx	Whithorn complex	0-90	Fibric Peat	Pt	—	—	—	—	—	3.5-5.0	none	—	—	at or near surface
		90-170	Mesic Peat	Pt	—	—	—	—	—	5.0-6.5	none	—	—	
		170 +	L-C	ML-CH	A-4 to A-7	100	100	70-90	0.3	7.5-8.0	low	low	high	
Wr	Warpath	0-10	C	CH	A-7-6	100	95-100	90-95	0.05	7.0-7.5	none	low	high	0.5-1.0 m
		10-120	SiC	CH	A-7-7	100	95-100	90-95	0.05	7.0-8.0	low	low	high	
		pockets	SiL	ML	A-4	100	90-100	70-90	1.5-2.5	7.5-8.0	low	low	mod.	
Wax	Waskwei complex	0-60	Fibric Peat	Pt	—	—	—	—	—	4.5-5.5	low	—	—	at surface
		60-170	Mesic Peat	Pt	—	—	—	—	—	5.5-7.0	low	—	—	
		170 +	L-C	ML-CH	A-4 to A-7	100	100	70-90	0.3	7.5-8.0	low	low	mod. to high	
Wy	Westray	0-10	L	ML	A-4	100	95-100	70-90	2.5-5.0	6.5-7.0	none	low	mod.	1 m
		10-100	SiL	ML	A-4	100	90-100	70-90	1.5-2.5	7.5-8.0	none	low	mod.	

TABLE 62

Codes utilized to identify limitations in evaluating soil suitability for selected uses (Tables 65 to 78)

a	subgrade properties
b	thickness of topsoil
c	coarse fragments on surface
d	depth to bedrock
e	erosion or erodibility
f	susceptibility to frost hazard
g	contamination hazard of groundwater
h	depth to seasonal water table
i	flooding or inundation
j	thickness of slowly permeable material
k	permeability or hydraulic conductivity
l	shrink-swell properties
m	moisture limitations or deficit
n	salinity or sulphate hazard
o	organic mater
p	stoniness
q	depth to sand or gravel
r	rockiness
s	surface texture
t	topographic slope class
u	moist consistence
w	wetness or soil drainage class
z	permafrost

Guides for Assessing Soil Suitability

Guides for assessing soil suitability for ten engineering related uses are given in Appendix D,(Tables 65 through 74). These tables provide as specifically as possible, definitions of the soil properties which result in the specific suitability or degree of limitation. In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very poor", then the overall rating of the soil for that selected use is "Very poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

RECREATION

Recreational development of the soils

This section provides interpretations of soil suitability for recreational development. All kinds

TABLE 63
Suitability Ratings of Soils for Selected Engineering Uses

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
As	Askandigau	Pws	Vah	Pwl	Vwf	Vwf	Vw	Pw	Psw	G	Vkh
As(P)	Askandigau	Pws	Vah	Pwl	Vwf	Vwf	Vw	Pw	Psw	G	Vkh
At	Atikameg	Pp	Va	Fap	Pp	Fa	Pp	G	Pp	Fkp	Pk
B	Big Lake	Pi	Va	Pw	Vwi	Vi	Vwi	Vwi	Pw	Vi	Pi
B(d)	Big Lake	Fi	Va	Pw	Vwi	Pwi	Vwi	Pwi	Pw	Vi	Pi
B(P)	Big Lake	Vw	Va	Vw	Vwi	Vi	Vwi	Vwi	Vw	Vi	Vi
Bc	Birch Bay	Pp	Va	Fdp	Pdp	Fdp	Vdr	Fw	Pdp	Pdg	Pdg
Be(d)	Big Eddy	Pa	Va	Pwa	Pw	Pwa	Vws	Pw	Pws	Vk	Pig
C	Carrot	Fi	Va	Fwa	Pw	Fwa	Pwi	Fw	G	Fa	G
Ca	Cayer	Pw	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Chx	Chocolate	Pw	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Ci	Chitek	Pp	Va	Fwp	Pwp	Fwp	Pwp	Fw	Fs	Fka	Pk
Cl	Cedar Lake	Ps	Va	Pl	Pa	Pa	Ps	G	Ps	G	Vk
Cp	Catfish Point	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
cR	Carbonate Bedrock	Vb	Va	Vdr	Vdr	Vr	Vr	Vk	Vd	Vd	Vd
Cr	Crane	Pw	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Dp	Davis Point	Ps	Va	Pal	Pa	Pa	Psw	Fw	Fs	G	Vk
Dr	Dering	Pp	Va	Pw	Pw	Pw	Vw	Pw	Pw	Ph	Ph
Dr(P)	Dering	Pp	Va	Vw	Vw	Pw	Vw	Vw	Vw	Vh	Vh
Dv	Duck River	G	Va	Fwa	Pw	Fw	Pw	Fw	G	Fa	G
Ea(P)	Easterville	Vw	Ph	Vw	Vw	Vw	Vw	Vw	Vw	Ph	Ph
Ei	Egg Island	Ps	Va	Pa	Pd	Pa	Vd	G	Ps	Pd	Pdg
Fd	Fairford	Pp	Va	Fap	Pp	Fa	Pp	G	Pp	Fkp	Pk
Fo	Foley	Fi	Va	Pw	Pw	Pw	Vw	Pw	Pw	Pi	Phi
Fo(P)	Foley	Pi	Va	Vw	Pw	Pw	Vw	Vw	Vw	Vi	Phi
Fx	Freshford	Psb	G	G	G	G	Vsk	Vk	Vs	Vak	Gg
Gdx	Grindstone	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Ghx	Guy Hill	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Hb	Homebrook	Ps	Va	Pi	Pa	Pa	Ps	G	Ps	G	Vk
Hl	Halcrow	Pw	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Ho	Homestead	Fi	Va	Fwa	Pw	Fwa	Pw	Fw	Vs	Pka	Pk
Hrx	Horseshoe Island	Ps	Fa	Fw	Pw	Fw	Fs	Fw	Vs	Va	Pk
Hw	Howell	Pw	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
In	Inwood	Pp	Va	Fwp	Pwp	Fwp	Pwp	Fw	Fs	Fka	Pk
Kc	Kircro	Pw	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Ki	Kinwow	Pp	Va	Pa	Pp	Fap	Psp	G	Psp	Fp	Pk
Ko	Koostatak	Pws	Vah	Pwl	Vwf	Vwf	Vw	Pw	Psw	G	Vkh
Ko(P)	Koostatak	Pws	Vah	Pwl	Vwf	Vwf	Vw	Pw	Pw	G	Vkh
Kt	Katimik	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Kx	Kilkenny	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Li	Limestone Point	Pp	Va	Fdp	Pd	Fdp	Vdr	Gg	Pdp	Pdg	Pdg
Li(s)	Limestone Point	Pb	Va	Vd	Vd	Pd	Vdr	Pk	Vd	Vd	Vd
Llx	Lamb Lake	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Lp	Le Pas	Pis	Va	Pwl	Pwi	Pwi	Vw	Pwi	Ps	Vi	Vk
Lt	Lettonia	Psu	Va	Pal	Pa	Pa	Ps	G	Ps	G	Pk
Mg	Mantagao	Pp	Va	Pa	Pp	Pa	Pwp	Fw	Psp	Fp	Pk
Mh	Marsh Complex	Vw	Va	Vw	Vwa	Vwa	Vw	Vw	Vw	Vi	Vi
Ml	Meleb	Pp	Va	Pw	Pw	Pw	Vw	Pw	Pw	Ph	Ph
Ml(P)	Meleb	Pp	Va	Vw	Vw	Pw	Vw	Vw	Vw	Vh	Vh
Mu	Mukatawa	Ps	Va	Pal	Pa	Pa	Psw	Fw	Fs	G	Vk

TABLE 63 (Continued)

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
Mx	Molson	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
N	Nels	Fi	Va	Fwa	Pw	Fw	Pw	Fw	G	Fa	G
Nb(P)	Napanee Bay	Ps	Va	Pwl	Pw	Pw	Vw	Pw	Pw	Fa	Vk
Nlx	Nekik Lake	Vz	Va	Vaz	Vaz	Vaz	Vsz	Vsz	Vsz	Vz	Vz
No	Novra	Pi	Va	Pw	Vwi	Vi	Vwi	Vwi	Pw	Vi	Vi
No(P)	Novra	Vw	Va	Vw	Vwi	Vwi	Vwi	Vh	Vw	Vi	Vi
Nr	Norris	Ps	Ph	Pw	Pwh	Pw	Vw	Phw	Vs	Va	Vhg
Nr(P)	Norris	Vw	Ph	Vw	Pwh	Pw	Vw	Vhw	Vsw	Va	Vhg
Orx	Orok	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Ox	Okno	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Ov	Overflowing	Vws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
P	Pasquia	Pi	Va	Pw	Vi	Pwi	Vwi	Vwi	Pw	Vi	Pi
P(d)	Pasquia	Fi	Va	Pw	Vi	Pwi	Vwi	Pwi	Pw	Vi	Pi
P(P)	Pasquia	Vw	Va	Vw	Vwi	Vwi	Vwi	Vwi	Vw	Vi	Vi
Rex	Reed Lake Complex	Pw	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Rlx	Rock Island	Vws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Rrx	Rat River	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Sb	Sandbeaches	Ps	Fa	Fw	Ph	Pi	Vhi	Vki	Vs	Vi	Vig
Sd	Stead	Vws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Sf	Swanford	G	Va	Fwa	Pw	Fw	Pw	Fw	G	Fa	G
Sfx	Salt Flat Complex	Vn	Va	Vw	Vw	Vw	Vw	Vw	Vw	Vh	Vh
Sm(P)	Sagamece	Pws	Vah	Pwl	Vwf	Vwf	Vw	Pw	Psw	G	Vkh
Sox	Soul Lake	Ps	Fa	G	Fa	G	Fp	Vk	Vs	Pa	Fkg
Srx	Sand River	Vws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Tux	Tremaudan	Ps	G	Fw	Pw	Fw	Vsk	Vk	Vs	Vk	Phg
Whx	Whithorn	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Wr	Warpath	Ps	Va	Pal	Pa	Pa	Psw	Fw	Fs	G	Vk
Wsx	Waskwei	Psw	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
Wy	Westray	Pp	Va	Fap	Fp	Fa	Pp	G	Pp	Fka	Pk

of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for camp sites, roads, play grounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The criteria used to evaluate soil suitability for recreational uses in many cases relate to engineering properties of soils and are adapted from guides found in Coen et al[28], and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[29] and the Canada Soil Survey Committee[30].

Soil suitability for selected recreation uses

The suitability of the various soil series and phases for selected recreation uses is shown in Table 64, according to four classes, Good, Fair, Poor and Very poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols are provided in Table 62 and the Glossary.

Guides for Assessing Soil Suitability for Recreation Use

The guidelines for various recreation uses are presented in Appendix D, Tables 68 and 75 through 78.

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[28] Coen et al, 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37. 208pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[29] USDA, 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service USDA. SCS-45. 87pp.

[30] CSSC, 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357pp.

TABLE 64
Suitability Ratings of Soils for Recreational Uses

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Paths And Trails	Permanent Bldgs. Without Basements
As	Askandigau	Vw	Pws	Vws	Pws	Vw
As(P)	Askandigau	Vsw	Psw	Vsw	Vsw	Vw
At	Atikameg	Pp	Fp	Pp	Fsp	Fa
B	Big Lake	Vw	Vw	Vw	Vw	Pw
B(d)	Big Lake	Pw	Pw	Pw	Pw	Pw
B(P)	Big Lake	Vw	Vw	Vw	Vw	Vw
Bc	Birch Bay	Pwp	Fwp	Pwp	Fwp	Pp
Be(d)	Big Eddy	Pws	Pws	Pws	Pws	Pwa
C	Carrot	Fw	Fw	Fw	Fw	Fw
Ca	Cayer	Vsw	Vsw	Vsw	Vsw	Vaw
Chx	Chocolate	Vsw	Vsw	Vsw	Vsw	Vaw
Ci	Chitek	Pp	Fwp	Pp	Pwp	Fwp
Cl	Cedar Lake	Fs	Fs	Fs	Fs	Pa
Cp	Catfish Point	Vsw	Vsw	Vsw	Vsw	Vaw
cR	Carbonate Bedrock	Vsw	Vsw	Vsw	Vsw	Vsw
Cr	Crane	Vsw	Vsw	Vsw	Vsw	Vaw
Dp	Davis Point	Pw	Pw	Pw	Fs	Pa
Dr	Dering	Pwp	Pw	Pwp	Pw	Pw
Dr(P)	Dering	Vw	Vw	Vw	Vw	Vws
Dv	Duck River	Fw	Fw	Fw	Fw	Fw
Ea(P)	Easterville	Vw	Vw	Vw	Vw	Vw
Ei	Egg Island	Ps	Ps	Ps	Ps	Pa
Fd	Fairford	Pp	Fp	Pp	Fsp	Fa
Fo	Foley	Pw	Pw	Pw	Pw	Pw
Fo(P)	Foley	Vw	Vw	Vw	Vw	Vw
Fx	Freshford	Pm	Fs	Fs	G	G
Gdx	Grindstone	Vsw	Vsw	Vsw	Vsw	Vaw
Ghx	Guy Hill	Vsw	Vsw	Vsw	Vsw	Vaw
Hb	Homebrook	Fs	Fs	Fs	Fs	Pa
Hl	Halcrow	Vsw	Vsw	Vsw	Vsw	Vaw
Ho	Homestead	Fw	Fw	Fwi	Fw	Fw
Hrx	Horseshoe Island	Ps	Fws	Fws	Fw	Fw
Hw	Howell	Vsw	Vsw	Vsw	Vsw	Vaw
In	Inwood	Pp	Fwp	Pp	Pwp	Fwp
Kc	Kircro	Vsw	Vsw	Vsw	Vsw	Vaw
Ki	Kinwow	Pp	Fs	Fp	Fp	Fp
Ko	Koostatak	Vsw	Psw	Vsw	Psw	Vwf
Ko(P)	Koostatak	Vsw	Psw	Vsw	Vsw	Vwf
Kt	Katimik	Vsw	Vsw	Vsw	Vsw	Vaw
Kx	Kilkenny	Vsw	Vsw	Vsw	Vsw	Vaw
Li	Limestone Point	Fpd	Fps	Fps	Fps	Pp
Li(s)	Limestone Point	Pdp	Fwp	Fwp	Fwp	Pd
Llx	Lamb Lake	Vsw	Vsw	Vsw	Vsw	Vaw
Lp	Le Pas	Pws	Pws	Pws	Pws	Pwa
Lt	Lettonia	Fpd	Fps	Fps	Fps	Pp
Mg	Mantagao	Psw	Ps	Psw	Ps	Fw
Mh	Marsh Complex	Vw	Vw	Vw	Vw	Vw
Ml	Meleb	Pw	Pw	Pwp	Pw	Pw
Ml(P)	Meleb	Vw	Vw	Vw	Vw	Vws
Mu	Mukatawa	Psw	Ps	Psw	Ps	Paf
Mx	Molson	Vsw	Vsw	Vsw	Vsw	Vaw
N	Nels	Fw	Fw	Fw	Fw	Fw
Nb(P)	Napanee Bay	Vws	Vws	Vws	Vws	Vw
Nlx	Nekik Lake	Vsw	Vsw	Vsw	Vsw	Vsw
No	Novra	Vw	Vw	Vw	Vw	Pw
No(P)	Novra	Vw	Vw	Vw	Vw	Vw
Nr	Norris	Pw	Pwc	Pwc	Pwc	Pw
Nr(P)	Norris	Vws	Vws	Vws	Vws	Vw
Orx	Orok	Vsw	Vsw	Vsw	Vsw	Vaw
Ox	Okno	Vsw	Vsw	Vsw	Vsw	Vaw

TABLE 64 (Continued)

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Paths And Trails	Permanent Bldgs. Without Basements
Ov	Overflowing	Vsw	Vsw	Vsw	Vsw	Vaw
P	Pasquia	Vw	Vw	Vw	Vw	Pw
P(d)	Pasquia	Pw	Pw	Pw	Pw	Pw
P(P)	Pasquia	Vw	Vw	Vw	Vw	Vw
Rex	Reed Lake Complex	Vsw	Vsw	Vsw	Vsw	Vaw
Rlx	Rock Island	Vsw	Vsw	Vsw	Vsw	Vaw
Rrx	Rat River	Vsw	Vsw	Vsw	Vsw	Vaw
Sb	Sandbeaches	Pws	Pw	Pwi	Fwi	Pw
Sd	Stead	Vsw	Vsw	Vsw	Vsw	Vaw
Sf	Swanford	Fw	Fw	Fw	Fw	Fw
Sfx	Salt Flat Complex	Vw	Vw	Vw	Vw	Vw
Sm(P)	Sagamece	Vsw	Psw	Vsw	Vsw	Vw
Sox	Soul Lake	Pm	Fs	Fs	G	G
Srx	Sand River	Vsw	Vsw	Vsw	Vsw	Vaw
Tux	Tremaudan	Fw	Fw	Fw	Fw	Fw
Whx	Whithorn	Vsw	Vsw	Vsw	Vsw	Vaw
Wr	Warpath	Pw	Pw	Pw	Fs	Pa
Wsx	Waskwei	Vsw	Vsw	Vsw	Vsw	Vaw
Wy	Westray	Pp	Fp	Pp	Fsp	Fa

Appendix A

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7.0.

Acidity - (Alkalinity) - The degree of acidity of the soil expressed in pH values. See Reaction, soil.

Afforestation - The artifical establishment of forest crops by planting or sowing on land that has not previously, or recently, grown trees.

Alluvium - A general term for all deposits of rivers and streams.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occuring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil up to approximately 15 atmospheres pressure.

Basal Area - The area of the cross section (measured inside or outside the bark, usually the latter) of a single tree or all trees in a stand, expressed either in square feet or square meters.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

Bedrock - The solid rock that underlies soil and regolith or that is exposed at the surface.

Biomass - The total amount of living material in a particular habitat or area (in forestry pertaining to plant biomass or tree biomass).

Boulders - Stones which are larger than 60 cm in diameter.

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
v. strongly calcareous	26-40%
extremely calcareous	>40%

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Clear Cutting - A method of cutting that removes the entire timber stand on the area cut.

Cobbles - Rock fragments 8 to 25 cm in diameter.

Color - Soil colors are compared with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color: hue, value and chroma. For example: 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Complex (soil) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity electrical - A physical quantity that measures the readiness with which a medium transmits electricity. It is expressed as the reciprocal of the electric resistance (ohms) or millisiemens per cm at 25 degrees C of a conductor which is one cm long with a cross sectional area of one square cm. It is used to express the concentration of salt in irrigation water or soil extracts.

Conifer - A tree belonging to the order Coniferae with cones and evergreen leaves of needle shape or "scale like". The tree is harvested to produce wood known commercially as "softwood".

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapotranspiration. and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection
2. In forestry, low growing shrubs and herbaceons plants under trees (i.e., ground cover vs. tree cover)
3. Any vegetation producing a protective mat on or just above the soil surface.

Cover Type - A descriptive term used to group together softwood (coniferous), hardwood (deciduous), or mixed wood (a mixture of softwoods and hardwoods) stands.

Creep (soil) - Slow mass movement of soil and soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and by alternate freezing and thawing.

Crown - The upper part of a tree, including the branches and foliage.

Crown Class - All trees in a stand with tops or crowns occupying a similar position in the canopy or crown cover. Crown classes usually distinguished are:

dominant:	Trees with crowns extending above the general level of the forest canopy and receiving full light from above and partly from the side; larger than the average trees in the stand and with crowns well developed but possibly somewhat crowded on the sides.
co-dominant:	Trees with crowns forming the general upper level of the forest canopy with the dominants receiving full light from above, but comparatively little from the sides; usually with small crowns and stem diameter; considerably crowded on the sides.
intermediate:	Trees with crowns below but still extending into the general level of the forest canopy, receiving a little direct light from above but none from the sides; usually with small crowns and stem diameter; considerably crowded on the sides.

Crown Cover - The canopy formed by the crown of all the trees in a forest.

Cut-over Forest - A forest in which most or all of the merchantable timber has been cut.

Deciduous Tree - A tree that sheds all its leaves every year at a certain season.

Decile portion - A one-tenth portion. As used in the soil map symbol A7 B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - A fluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Diameter Breast Height (DBH) - The diameter of a tree 1.35 m above ground level.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily; a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high;

contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water storage capacity, Texture, and depth, and are either Gleysolic or Organic.

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Even-aged - A stand of trees in which only small differences in age occur between the individuals.

Farm Forestry - The practice of forestry on farm or ranch land, generally integrated with other farm or ranch operations.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to innundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Forest - A plant association predominantly of trees and other woody vegetation.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Granular Structure - Soil structure in which the individual grains are gouped into small block-like aggregates with indistinct or round edges (spheriodal).

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Gross Mean Annual Increment (GMAI) - Total growth of trees in a stand up to a given age, divided by that age.

Gross Merchantable Volume - Total volume of wood being removed from the forest (unculled).

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by ablation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping hills and enclosed depressions.

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - vegetation that grows naturally in soils having a high content of various salts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Hardwoods - A term applied to one of the botanical groups of trees that have broad leaves; also wood produced by trees of this group regardless of texture.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The Form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm. per hour.

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

Illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Increment - The increase in diameter basal area, height, volume, quality, or value of a tree or stand during a given period.

Indicator plant - Any plant that by its presence, its frequency or its vigor indicates any particular property of the site-particularly but not exclusively of the soil.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Appendix C.

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinquish one part of the earth's surface from another part.

Leaching - The removal from the soil of materials in solution.

Limiting Factor - A factor whose absence, or excessive concentration, exerts some restraining influence upon a population through incompatibility with species requirements or tolerance.

Liquid limit (upper plastic limit) - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually field moisture equivalent) to the shrinkage limit.

Litter - A surface layer of loose organic debris in forests, consisting of freshly fallen or slightly decomposed organic materials.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Maturity - The approximate age beyond which growth falls off or the rate of decay increases.

Merchantable Volume (Net) - Volume of wood of a size and quality suitable for marketing and utilization.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

Microrelief - Small-scale, local differences in relief including mounds, swales or hollows.

Milliequivalent (me) - One-thousandth of an equivalent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mixed Forest - A forest composed of two or more species of trees. In practice, usually a forest in which at least 20% are trees of other than dominant species. Frequently applied to forests consisting of a combination of hardwood softwood species.

Modified Clear Cutting - A clear cutting system in which the size and shape of the cut areas are varied to provide a source of seed for the cut areas from timber margins.

Moisture Regime - Annual moisture status of the unconsolidated soil material, expressing the moisture available to trees in descriptive terms. The broad classes used by foresters are given below with the approximate equivalent terms used by soil surveyors.

Dry	periodic to prolonged lack of soil moisture (excessively drained).
Fresh	adequate soil moisture supply, without prolonged lack or excess of soil moisture (well drained).
Moist	periodic excess of soil moisture (imperfectly drained).
Wet	prolonged to permanent excess to soil moisture (poorly drained).
Saturated	permanent excess of soil moisture at the surface (very poorly drained).

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

Outwash - Sediments "washed out" beyond the glacier by flowing water and laid down in thin beds or strata. Particle size may range from boulders to silt.

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Overstory - The portion of the trees in a forest stand forming the upper crown cover.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Partial Cutting - A system of cutting in which only a portion of the stand is removed during the first cut. The remainder of the stand is used as a seed source and to provide shade for seedlings, and is ordinarily removed following the successful establishment of reproduction.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons.

The particle-size classes for family groupings are as follows:

Fragmental Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Loamy-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

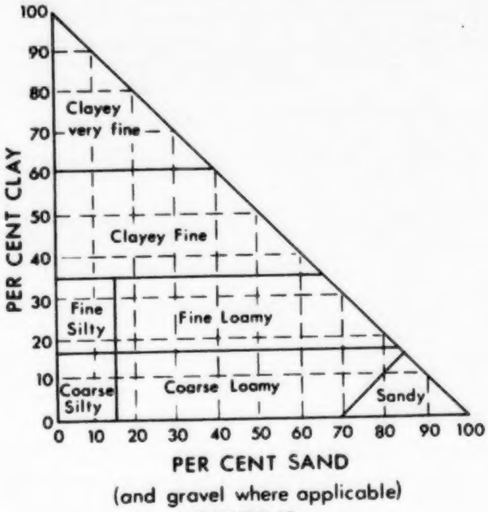


FIGURE 33

Family particle-size classes.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Percolation - The downward movement of water through soil. specifically, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permafrost -

1. Perennially frozen material underlying the solum.
2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. It is described as rapid, moderate or slow.

pH - The intensity of acidity and alkalinity, expressed as the logarithm of the reciprocal of the H + concentration. pH 7 is neutral, lower values indicate acidity and higher values alkalinity.

Phase, soil - A soil phase is a unit of soil outside the system of soil taxonomy. It is a functional unit and is used at any categorical level from Order to Series. It is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Plastic Limit - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity Index - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Pure Forest - A forest composed essentially of trees of one species. In practice, a forest in which at least 80% of the trees are of one species.

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

extremely acid	pH < 4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
mildly alkaline	7.4 to 7.8
mod. alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	> 9.0

Reforestation - Restocking an area with forest trees.

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Relief - The elevation of inequalities of the land surface when considered collectively.

Rotation age - The age at which trees have grown to a specific maturity and are harvested.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisemens/cm (mS/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

non-saline	0 to 4 mS/cm
slightly saline	5 to 8 mS/cm
mod. saline	9 to 15 mS/cm
strongly saline	> 15 mS/cm

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.
2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface texture and are formed from a particular type of parent material.

Shelterbelt - See Windbreak

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Site - An area of land characterized by regional and local climate, soil material, relief, soil moisture and nutrients which influence the development of the biotic communities on that land.

Site Index - A numerical expression commonly accepted as an indicator of the quality or timber productivity of a site. It is an expression of the height-age relationship of the tallest trees (dominants and co-dominants) in normal stands at some designated age (usually rotation age).

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exhange reactions with soil. Where the ionic concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stand - An aggregation of trees or other growth occupying a specific area and sufficiently uniform in composition (species), age arrangement, and condition to be distinguishable from the forest or other growth on adjoining areas.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The relative proportion of stones in or on the soil. The classes of stoniness are defined as follows:

Stones O. Nonstony – Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony – Land having 0.01-0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony – Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony – Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony – Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony – Land having more than 50% of surface occupied by stones. Stones 15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Structure - The combination or arrangement of primary soil particles into secondary soil particles, units or peds, which are separated from adjoining aggregates by surfaces of weakness. Aggregates differ in grade (distinctness) of development. Grade is described as structureless (no observable aggregation or no definite orderly arrangement amorphous if coherent, single-grained if noncoherent), weak, moderate, and strong. The aggregates vary in class (size) and are described as fine, medium, coarse, and very coarse. The size classes vary according to the type (shape) of structure. The types of structure are:

Granular - Having more or less rounded aggregates without smooth faces and edges

Platy - Having thin, plate-like aggregates with faces mostly horizontal

Blocky - Having block-like aggregates with sharp, angular corners

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky and moderate, coarse, granular. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Sucker - Shoots that arise from the lower portion of a stump, especially from the root, following cutting of the original stem.

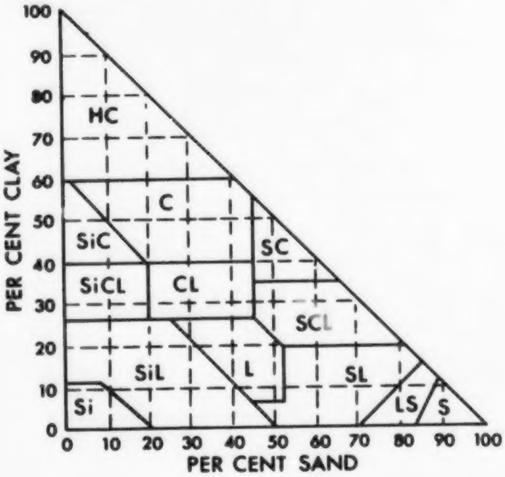
Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil samples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - See Appendix C

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons.

The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002
Fine clay	< 0.0002



Texture Group	Class Symbol	Class Name
Coarse	S LS	Sand Loamy sand
Moderately coarse	SL FSL	Sandy loam Fine sandy loam
Medium	Si SiL L VFSL	Silt Silt loam Loam Very fine sandy loam
Moderately fine	SCL CL SiCL	Sandy clay loam Clay loam Silty clay loam
Fine	SC C SiC	Sandy clay Clay Silty clay
Very fine	HC	Heavy clay

FIGURE 34

Soil Textural Classes.

Till, glacial - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or frequency of slopes in different directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit.

Slope Class	Slope Name	Percent slope	Approx. degrees
1	level	0-0.5	0
2	nearly level	.5-2.5	.3-1.5
3	very gentle	2-5	1-3
4	gentle	6-9	3.5-5
5	moderate	10-15	6-8.5
6	strong	16-30	9-17
7	very strong	31-45	17-24
8	extreme	46-70	25-35
9	steep	71-100	35-45
10	very steep	>100	>45

Underground runoff - (or seepage)-Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Understory - That portion of the trees in a forest below the upper crown cover.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water-holding capacity - The ability of a soil to hold water. The water-holding capacity of sandy soils is usually considered to be low, while that of clayey soils is high. It is often expressed in cm of water per 30 cm depth of soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Windbreak -

1. A living barrier of trees or combination of trees and shrubs located adjacent to farm or ranch headquarters and designed to protect the area from cold or hot winds and drifting snow.
2. A narrow barrier of living trees or combination of trees and shrubs, usually from one to five rows, established within or around a field for the protection of land and crops from wind.

Woodlot - A relatively restricted area devoted to the growing of forest trees.

Xerophyte - Plants capable of surviving extended periods of soil drought.

Appendix B

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decompostion with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or of humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral, grains, especially near the junction with the mineral horizon.

MASTER MINERAL HORIZONS

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizons.

A This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:

1. horizons in which organic matter has accumulated as a result of biological activity (Ah);
2. horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);
3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);
4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);
2. a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);
3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

R This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet the requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact.

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

LOWER-CASE SUFFIXES

b Buried soil horizon.

c A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples.

ca A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10cm thick, and if it has a $CaCO_3$ equivalent of less than 15 percent it should have at least 5 percent more $CaCO_3$ equivalent than the parent material (IC). If it has more than 15 percent $CaCO_3$ equivalent it should have 1/3 more $CaCO_3$ equivalent than IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.

cc Cemented (irreversible) pedogenic concretions.

e A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.0002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf-more than 5% organic carbon.

g A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg This horizon must meet the definitions of A,e, and g.

Bg These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by more prominent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.

Bfg, Bhfg, Btg, and others When used in any of these combinations the limits set for f, hf, t, and others must be met.

Bgf The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag When g is used with C alone, or with C and one of the lower-case suffixes k, ca, s, or sa, it must meet the definiton for C and for the particular suffix.

h A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

Ah A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

Ahe An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.

Bh This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable Fe of 20 or more. Generally the color value and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

m A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1. Evidence of alteration in one of the following forms:
    - a) Higher chromas and redder hues than the underlying horizons.
    - b) Removal of carbonates, either partially (Bmk) or completely (Bm).

2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.

3. Some weatherable minerals.

4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 mS/cm and must exceed that of the C horizon by at least one-third.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:
    - a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3% more clay, e.g.,Ae 10% clay-Bt minimum 13% clay.
    - b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.

c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.

2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.

3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.

4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.

5. If a soil shows a lithologic discontinuity between the eluvial horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj Btj and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons,, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

Appendix C

DESCRIPTION OF LANDFORMS

GENETIC MATERIALS

Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed *Alluvium*.

Lacustrine - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but secondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

Organic component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

Particle size classes for unconsolidated mineral materials

Blocky:	An accumulation of angular particles greater than 256 mm in size.
Bouldery:	An accumulation of rounded particles greater than 256 mm in size.
Clayey:	An accumulation of particles where the fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.
Cobbly:	An accumulation of rounded particles having a diameter of 64-256 mm.
Gravelly:	An accumulation of rounded particles ranging in size from pebbles to boulders.
Loamy:	An accumulation of particles of which fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.
Pebbly:	An accumulation of rounded particles having a diameter of 2-64 mm.
Rubbly:	An accumulation of angular fragments having a diameter of 2-256 mm.
Sandy:	An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine sand or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.
Silty:	An accumulation ofparticles of which the fine earth fraction contains less than 15% of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

Fiber classes for organic materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric:	The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.
Mesic:	Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.
Humic:	Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.
Woody:	Organic material containing more than 50% of woody fibers.

SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Consolidated and Unconsolidated mineral surface classes

Apron - A relatively gently slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometines confined concave depressions to broad, rounded convexities producing a wavelake pattern of moderate relief. Slope length is often 1.6 km or greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometines confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the materials's genesis.

Organic surface classes

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the under-lying unit but still conforms to the general under-lying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 to 100 cm) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

Appendix D

GUIDES FOR ASSESSING SOIL SUITABILITY FOR SELECTED ENGINEERING AND RECREATION USES

TABLE 65.

Guide for assessing soil suitability as source of topsoil.

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristics of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
i	Flooding	None	May flood occasionally for short periods	Frequent flooding	Constantly flooded
w	Wetness[2]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	Slope	0-5%	5-9%	9-15%	> 15%
p	Stoniness[2]	Stones 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones 0.1 m apart (Class 5)
c	Coarse fragments[2]: percent, by volume	< 3%	3-15%	15-35%	> 35%
s	Texture[2]	FSL, VFSL, L, SiL, SL, SC if 1:1 clay is dominant	CL, SCL, SiCL, SC if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	S, LS, C and SiC if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	Depth of Topsoil[4]	> 40 cm	15-40 cm	8-15 cm	< 8 cm
n	Salinity of Topsoil[5]	E.C. 0-1	E.C. 1-4	E.C. 4-8	E.C. > 8

[1] The symbols are used to indicate the nature of the limitation.

[2] For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.

[4] The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.

[5] E.C. - Electrical Conductivity (millisiemens/cm).

TABLE 66.

Guide for assessing soil suitability as source of sand and gravel.

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of the soil substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Unified Soil Group	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other groups and bedrock
h	Depth to Seasonal Water Table	Not class determining if deeper than 50 cm		< 50 cm	
q	Depth to Sand and Gravel	< 25 cm	25-75 cm[2]	> 75 cm[2]	
p	Stoniness[3]	Not class determining if stones > .5 m apart (Class 0, 1, 2 and 3)		Stones 0.1-0.5 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
d	Depth to Bedrock	> 100 cm	50-100 cm	< 50 cm	

[1] The symbols are used to indicate the nature of the limitation.

[2] Rated good if it is known that the underlying gravel or sand deposit is thick (>100 cm).

[3] For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

TABLE 67.
Guide for assessing soil suitability as source of roadfill.

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Items Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	**Subgrade[3]**				
	a. AASHO group index[4]	0-4	5-8	> 8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5] and SC[5]	CL (with P.I.[6] < 15) and ML	CL (with P.I.[6] of 15 or more), CH and MH[7]	OL, OH and Pt
l	**Shrink-swell potential**	Low	Moderate	High	
f	**Susceptibility to frost action[8]**	Low	Moderate	High	
t	**Slope**	0-15%	15-30%	30-45%	> 45%
p	**Stoniness[9]**	Stones > 2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
r	**Rockiness[9]**	Rock exposures > 35 m apart and cover < 10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposures < 3.5 m apart and cover 50-90% of the surface
w	**Wetness[9]**	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	**Depth to Bedrock**	> 100 cm	50-100 cm	20-50 cm	< 20 cm
h	**Depth to Seasonal Water Table**	> 150 cm	75-150 cm	50-75 cm	< 50 cm

[1] The symbols are used to indicate the nature of the limitation.

[2] The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

[3] This item estimates the strength of the soil material, that is, its ability to withstand applied loads.

[4] Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

[5] Downgrade suitability rating to fair if content of fines is more than about 30 percent.

[6] P.I. means plasticity index.

[7] Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

[8] Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

[9] For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

TABLE 68
Guide for assessing soil suitability for permanent buildings[1].

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	*With Basements:* Very rapidly, rapidly and well drained. *Without Basements:* Very rapidly, rapidly, well and moderately well drained.	*With Basements* Moderately well drained. *Without Basements:* Imperfectly drained.	*With Basements:* Imperfectly, poorly, and very poorly drained. *Without Basements:* Poorly and very poorly drained.	*With Basements* Permanently wet soils. *Without Basements:* Permanently wet soils.
h	Depth to Seasonal Water Table	*With Basements:* > 150 cm *Without Basements:* > 75 cm	*With Basements:* 75-150 cm *Without Basements:* 50-75 cm	*With Basements:* 25-75 cm *Without Basements:* 25-50 cm	*With Basements:* < 25 cm *Without Basements:* < 25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	> 30%
a	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	> 8	
	b. Unified soil classes	GW, GP, SW, SP, SM and GC and SC	CL (with P.I. [8] < 15 and ML	CL (with P.I. [8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones > 10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class 2[10])	Stones 0.1-2 m apart (Class 3[10] to 4)	Stones < 0.1 m apart (Class 5[10])
r	Rockiness[4], [11]	Rock exposures >.100 m apart and cover < 2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures < 30 m apart and cover > 10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	*With Basements:* > 150 cm *Without Basements:* > 100 cm	*With Basements:* 100-150 cm *Without Basements:* 50-100 cm	*With Basements:* 50-100 cm *Without Basements:* < 50 cm	*With Basements:* < 50 cm

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[1] By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

[2] The symbols are used to indicate the nature of the limitation.

[3] Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

[4] For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Reduce the slope limits by one half for those soils subject to hillside slippage.

[6] This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

[7] Group index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23-25.

[8] P.I. means plasticity index.

[9] Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5-8.

[10] Rate one class better for buildings without basements.

[11] Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

TABLE 69.
Guide for assessing soil suitability for local roads and streets[1]

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime or soil cement stabilised soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	**Wetness[3]**	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	**Flooding**	None	Infrequent (once in 5 years)	Occasional (once in 2-4 years)	Frequent (every year)
t	**Slope**	0-9%	9-15%	15-30%	> 30%
d	**Depth to Bedrock[4]**	> 100 cm	50-100 cm	< 50 cm	
a	**Subgrade[5]**				
	a. AASHO group index[6]	0-4	5-8	> 8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[7] and SC[7]	CL (with P.I.[8] < 15 and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	**Susceptibility to Frost Heave[9]**	Low (F1, F2)	Moderate (F3)	High (F4)	
p	**Stoniness[3]**	Stones > 2 m apart (Class 0 to 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
r	**Rockiness[3]**	Rock exposures > 100 m apart and cover < 2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures < 30 m apart and cover > 10% of the surface	Rock exposures too frequent to permit location of roads and streets

[1] These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

[2] Symbols are used to indicate the nature of the limitation.

[3] For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

[4] Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

[5] This item estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

[6] Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23-25.

[7] Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

[8] P.I. means plasticity index.

[9] Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8.

TABLE 70.

Guide for assessing soil suitability for trench-type sanitary landfills[1].

The trench-type sanitary landfill is a sanitary landfill, in which dry garbage and trash is buried daily in an open trench and covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G[3]	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal High Water Table	Not class determining if more than 180 cm		100-180 cm	< 100 cm
w	Wetness[4]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	Flooding	None	R.	Occasional	Frequent
k	Permeability[5]	< 5 cm/hr	< 5 cm/hr	5-15 cm/hr	> 15 cm/hr
t	Slope	0-15%	15-30%	30-45%	> 45%
s	Soil Texture[4],[6] (dominant to a depth of 150 cm)	SL, L, SiL, SCL	SiCL[7], CL, SC, LS	SiC, C	Muck, peat, gravel, sand
d	Depth to Hard Bedrock Rippable	> 150 cm > 150 cm	> 150 cm 100-150 cm	100-150 cm 100-150 cm	< 100 cm < 100 cm
p	Stoniness[4]	Stones > 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Nature of Bedrock	Impermeable			Highly permeable, fractured, easily soluble

[1] Based on soil depth (120 cm) commonly investigated in making soil surveys.

[2] The symbols are used to indicate the nature of the limitation.

[3] If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".

[4] For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semi arid areas.

[6] Reflects ease of digging and moving (workability) and trafficability in the immediate are of the trench where they may not be surfaced roads.

[7] Soils high in expansive clays may need to be given a suitability rating of poor.

TABLE 71.

Guide for assessing soil suitability for area-type sanitary landfills.

In the area-type sanitary landfill refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated so as to determine the probability that leachates from the landfill can penetrate the soil and thereby pollute water supplies.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal Water Table[2]	> 150 cm	150-100 cm	50-100 cm	< 50 cm
w	Wetness[2],[3]	Rapid to moderately Well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[4],[5]	Not class determining if less than 5 cm/hr		5-15 cm/hr	> 15 cm/hr
t	Slope	0-9%	9-15%	15-30%	> 30%

[1] The symbols are used to indicate the nature of the limitation.

[2] Reflects influence of wetness on operation of equipment.

[3] For an explanation of drainage, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[4] Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semi arid areas.

[5] Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor for area-type sanitary landfills.

TABLE 72.
Guide for assessing soil suitability as cover material for area-type sanitary landfills.

The term cover material includes soil materials used to put a daily and final covering layer on refuse in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
s	Texture[2],[3]	SL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C	Muck, peat, sand, gravel
d	Depth to bedrock[4]	> 150 cm	100-150 cm	50-100 cm	< 50 cm
c	Coarse fragments[2]	< 15%	15-35%	> 35%	
p	Stoniness[2]	Stones > 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
t	Slope	< 9%	9-15%	15-30%	> 30%
w	Wetness[2]	Not class determining if better than poorly drained		Poorly drained	Very poorly drained or permanently wet soils

[1] The symbols are used to indicate the nature of the limitation.

[2] For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.

[4] Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

TABLE 73.
Guide for assessing soil suitability for reservoirs and sewage lagoons.

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage are considered for evaluating soils on their suitability for reservoir and lagoon areas. This evaluation considers soil both as a vessel for impounded area and as material for the enclosing embankment. As the impounded liquids could be potential sources of contamination of nearby water supplies, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Water Table[2]	> 150 cm	100-150 cm	50-100 cm	< 50 cm
i	Flooding[3]	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	Soil Permeability	0-0.5 cm/hr	0.5-5 cm/hr	5-15 cm/hr	> 15 cm/hr
t	Slope	0-2%	2-5%	5-9%	> 9%
o	Organic Matter	< 2%	2-10%	10-30%	> 30%
c	Coarse Fragments[4] < 25 cm in diameter, % by volume	< 20%	20-35%	> 35%	
p	Stoniness[4], > 25 cm diameter, percent of surface area	< 3% (Class 0, 1 and 2)	3-15% (Class 3)	15-50% (Class 4)	> 50% (Class 5)
d	Depth to Bedrock[5]	> 150 cm	100-150 cm	50-100 cm	< 50 cm
j	Thickness of Slowly Permeable Layer	> 100 cm	50-100 cm	50-25 cm	< 25 cm
a	Subgrade Unified Soil Classes	GC, SC, CL, & CH	GM, ML, SM & MH	SW & SP	OL, OH & Pt GP, GW

[1] The symbols are used to indicate the nature of the limitation.

[2] If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.

[3] Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).

[4] For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Surface exposures of non rippable rock are rated very poor. If underlying bedrock is impermeable, rating should be one class better.

TABLE 74.
Guide for assessing soil suitability for septic tank absorption fields.

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3] (Auger hole method)	About 8-18 min/cm[3]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4]	> 150 cm[5]	100-150 cm	50-100 cm	< 50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	> 30%
d	Depth to Hard Rock, bedrock or other impervious materials	> 150 cm	100-150 cm[6]	50-100 cm	< 50 cm

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[1] The symbols are used to indicate the nature of the limitation.

[2] The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

[3] Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. *The symbol g is used to indicate this condition.* Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

[4] Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

[5] A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

[6] Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

TABLE 75.
Guide for assessing soil suitability for playgrounds.

This guide applies to soils to be used for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permamently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	> 9%
d	Depth to Bedrock	> 100 cm	50-100 cm[3]	< 50 cm[3]	
c	Coarse fragments on surface[2]	Relatively free of coarse fragments.	< 20% coarse fragments.	> 20% coarse fragments.	
p	Stoniness[2]	Stones > 10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones < 0.1 m apart. (Class 5)
r	Rockiness[2]	Rock exposures > 100 m apart and cover < 2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures < 30 m apart and cover > 10% of the surface.	Rock outcrops too frequent to permit playground location.
s	Surface Soil Texture[2], [4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5]; S, Si	Peaty soils; S and S subject to blowing.
q	Depth to Sand or Gravel[6]	> 100 cm	50-100 cm	< 50 cm	
m	Useful Moisture[7]	Water storage capacity[8] > 15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] < 7.5 cm and/or low rainfall and/or high evapotranspiration.	

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[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).
Coarse fragments for the purpose of this table include gravels and cobbles.

[3] Downgrade to a very poor suitability rating if the slope is greater than 5%.

[4] Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

[5] Moderately well and well drained SC, SiC and C soils may be rated fair.

[6] Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

[7] This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

[8] Consult glossary for definitions of terms used.

TABLE 76.
Guide for assessing soil suitability for picnic areas.

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water Table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	Slope	0-9%	9-15%	15-30%	> 30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2]	0-20%	20-50%	> 50%	
p	Stoniness[2]	Stones > 2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2],[5],[6]	Rock exposures roughly 30-100 or more m apart and cover < 10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures < 10 m apart and cover > 25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
m	Useful Moisture[7]	Water storage capacity[8] > 15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] < 7.5 cm and/or low rainfall and/or high evaportranspiration.	

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[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purpose of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

[6] The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

[7] This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

[8] Consult glossary for definitions of terms used.

TABLE 77.
Guide for assessing soil suitability for camp areas.

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow rock exposures greater than 10 m apart to be considered a slight limitation.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	> 30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2],[5]	0-20%	20-50%	> 50%	
p	Stoniness[2],[6]	Stones > 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2],[6]	No rock exposures	Rock exposures > 10 m apart and cover < 25% of the area.	Rock exposures < 10 m apart and cover > 25% of the area.	Rock exposures too frequent to permit campground location.

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[6] Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

TABLE 78.
Guide for assessing soil suitability for paths and trails.

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Items[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Texture[3],[4]	SL, FSL, VFSL, LS, L	SiL, CL, SiCL, SCL	SC, SiC, C[5]; Sand, Si	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[6],[4]	0-20%	20-50%	> 50%	
p	Stoniness[4]	Stones > 2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
w	Wetness[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4],[7]	Rock exposures > 30 m apart and cover < 10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures < 10 m apart and cover > 25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[8]	0-15%	15-30%	30-60%	> 60%
i	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

[1] The symbols are used to indicate the nature of the limitation.

[2] The items affecting use listed on this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight affects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp, 1977).

[3] Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

[4] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Moderately well and well drained SC, SiC and C soils may be rated fair.

[6] Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

[7] The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

[8] Slope in this context refers to the slope of the ground surface, not the slope of the tread.

Appendix E

METHODS OF PHYSICAL AND CHEMICAL ANALYSIS

Bulk Density: - G.R. 1965. Bulk Density. In Agronomy No. 9 "Methods of Soil Analysis", Part 1. Black, C.A. Ed. 375.

Calcium Carbonate, Calcite and Dolomite: - Skinner, S.I.M., Halstead, R.L. and Brydon, J.E. 1959. Quantitative manometric determination of calcite and dolomite in soils and limestones. Can. J. Soil Sci. 39:197-204.

Cation exchange capacity and Ammonium acetate extractable cations: - Chapman, H.D. 1965. Cation Exchange Capacity. In agronomy No. 9. Methods of Soil Analysis, Part 2. Black, C.A. Ed. 891-899.

Conductivity: - U.S. Department of Agriculture. 1954. Diagnosis and improvement of saline and alkaline soils. Agric. Handbook No. 60.

Determination of Ca, Mg, Na, K: - "Analytical Methods for Atomic Absorption Spectrophotometry". 1973 edition. Perkin- Elmer Corp. Norwalk, Connecticut, U.S.A.

Exchange acidity: - Peech, M. 1965. Exchange Acidity. In agronomy No. 9. Methods of Soil Analysis. Part 2. Black, C.A. Ed. 910-911.

Liquid Limit: - "Procedures for texting soils". 1958. A.S.T.M. Designation D423-54T. 94-98.

Nitrogen: - Bremner, J.M. 1965. Total Nitrogen. In Agronomy No. 9. Methods of Soil Analysis. Part 2. Black, C.A. Ed. 1162-1164.

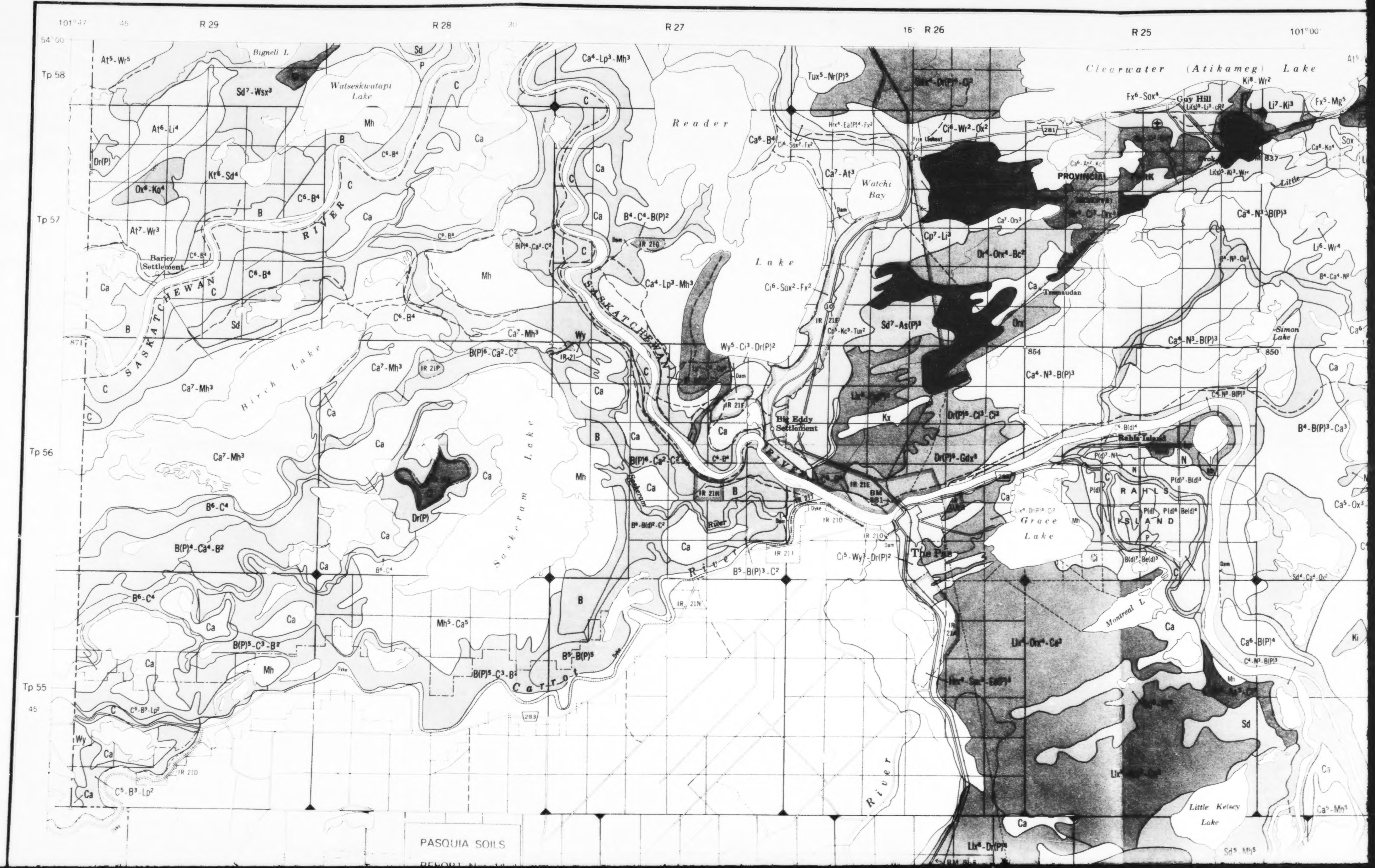
Organic Carbon: - Walkley, A. and Black, I.A. 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci. 37:29-38.

Particle size analysis: - Kilmer, V.J. and Alexander, L.T. 1949. Methods of making mechanical analysis of soils. Soil Sci. 68:15-24.

pH: - Peech, M. 1965. Hydrogen-ion activity. In Agronomy No. 9 "Methods of Soil Analysis", Part 2. Black, C.A. Ed. 891-899.

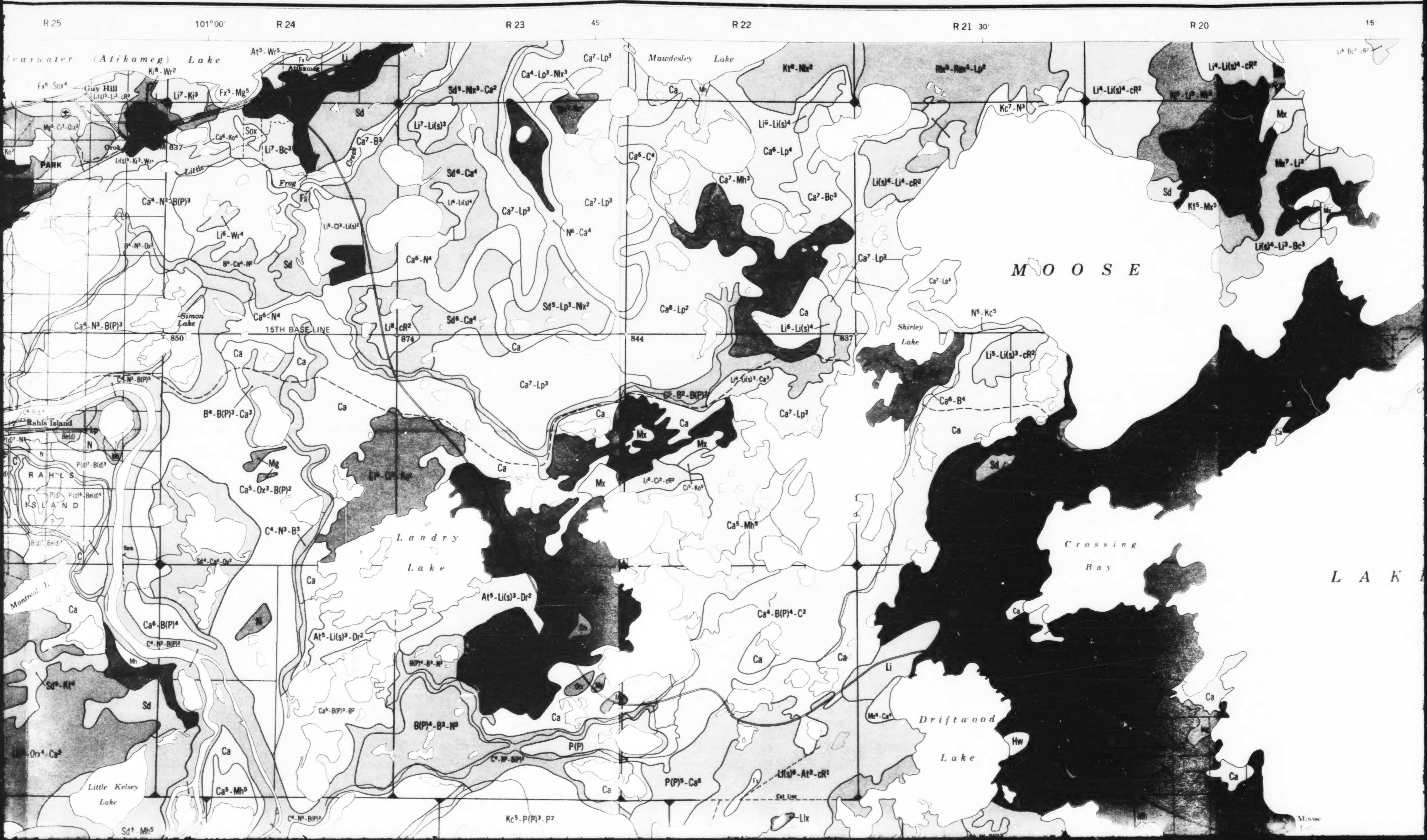
Plastic Limit: - "Procedures for testing soils". 1958. A.S.T.M. Designation D424-54T. 99-101.

Shrinkage Limit: - "Procedures for testing soils". 1958. A.S.T.M. Designation D424-39. 76-79.

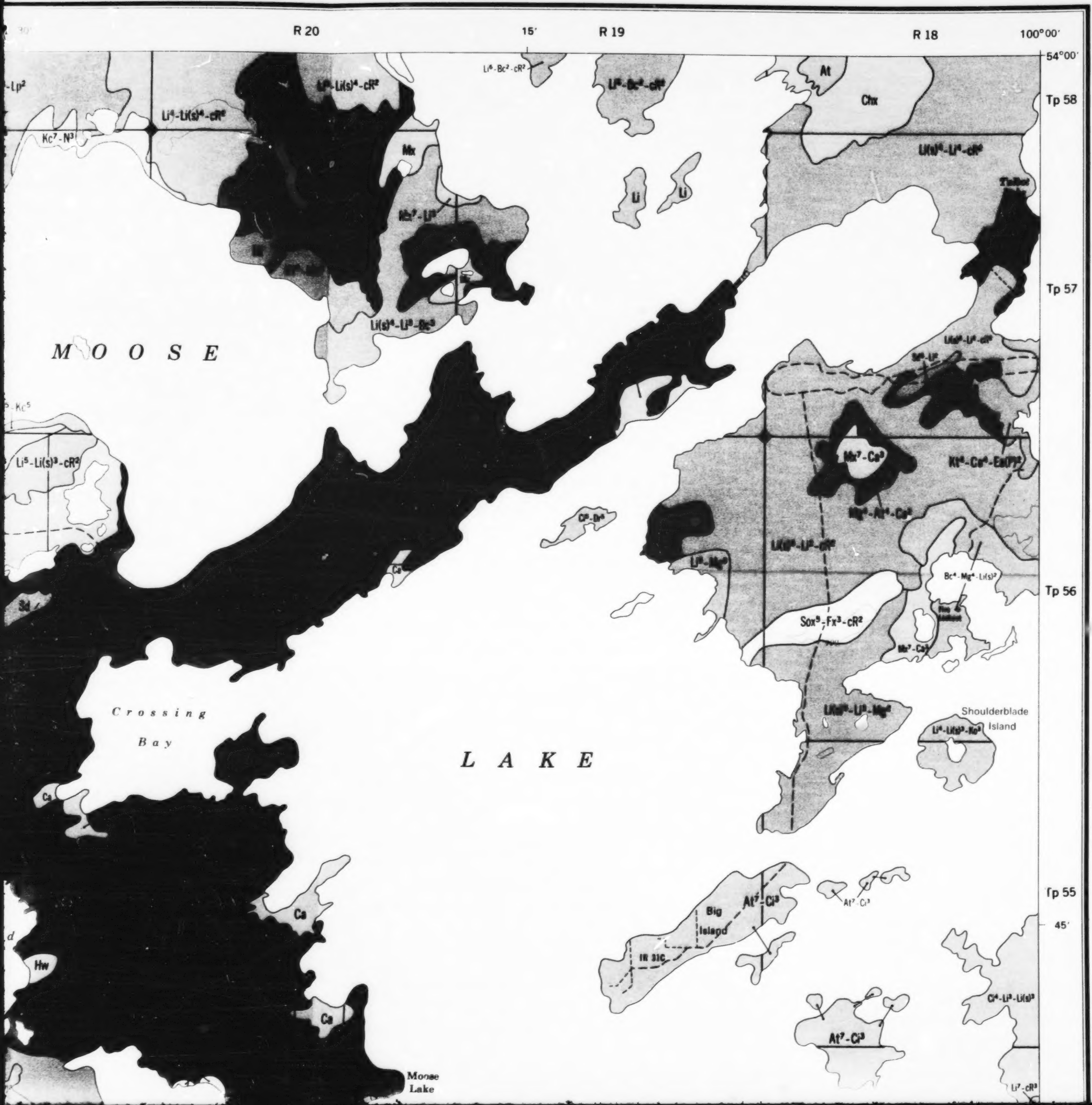


PASQUIA SOILS

REPORT N...

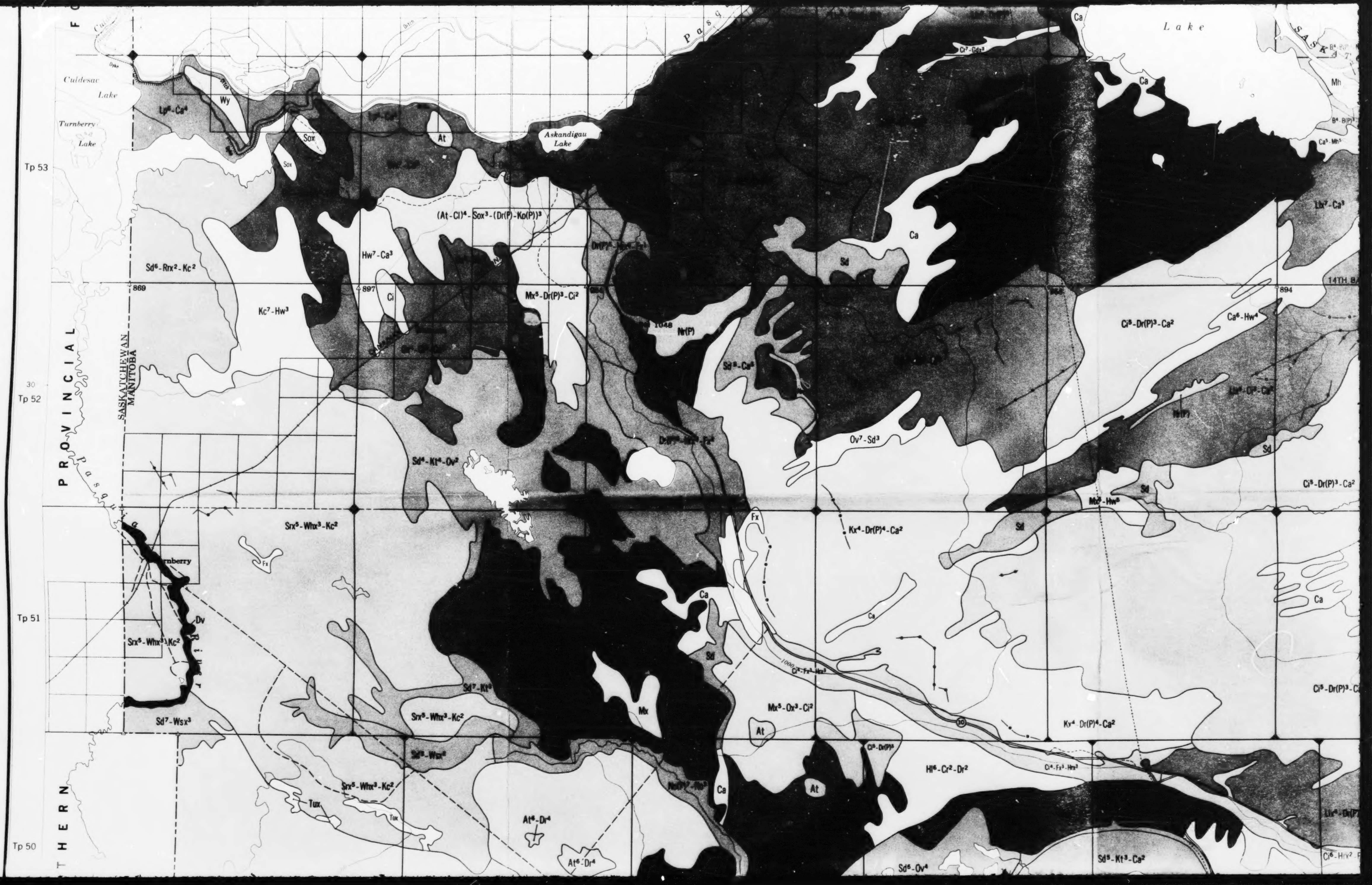


R 25
101°00'
R 24
R 23
45'
R 22
R 21
30'
R 20
15'
Clearwater (Atikameg) Lake
At⁵-Wr⁵
Ki⁸-Wr²
Fx⁶-Sox⁴
Guy Hill
Li⁷-Ki³
Fx⁵-Mg⁵
Atikameg
Sd
Sd⁵-Nlx³-Ca²
Ca⁷-Lp³
Ca⁴-Lp³-Nlx³
Mawdesley Lake
Kt⁶-Nlx²
Li⁴-Li(s)⁴-cR²
Li⁴-Li(s)⁴-cR²
Kc⁷-N³
PARK
Orok
837
Little
Frog
Creek
Sox
Li⁷-Bc³
Ca⁷-B³
Li⁷-Li(s)³
Sd⁶-Ca⁴
Li⁶-Li(s)⁴
Ca⁶-C⁴
Ca⁶-Lp⁴
Ca⁷-Mh³
Ca⁷-Bc³
Li(s)⁶-Li⁴-cR²
Mx
Mx⁷-Li³
Sd
Kt⁵-Mx⁵
Li(s)⁴-Li³-Bc³
Ca⁴-N³-B(P)³
Fx
Li⁶-Wr⁴
Ca⁷-Lp³
Ca⁷-Lp³
N⁶-Ca⁴
B⁴-N³-Ox³
B⁴-Ca⁴-N²
Sd
Ca⁶-N⁴
MOOSE
Ca⁷-Lp³
Ca⁷-Lp³
Ca⁴-N³-B(P)³
Simon Lake
Ca⁶-N⁴
Sd⁶-Ca⁴
Sd⁵-Lp³-Nlx²
Ca⁸-Lp²
Ca
Li⁶-Li(s)⁴
N⁵-Kc⁵
15TH BASE LINE
850
Li⁸-cR²
874
844
837
Shirley Lake
Li⁵-Li(s)³-cR²
Ca
Ca
Ca
C⁴-N³-B(P)³
Ca⁷-Lp³
C⁶-B²-B(P)³
Li⁴-Li(s)³-Ca³
Ca⁶-B⁴
Rahls Island
B⁴-B(P)³-Ca³
Ca
Ca⁷-Lp³
Ca
Ca
Mx
Mx
Ca
N
RAHLS ISLAND
Mg
Ca⁵-Ox³-B(P)²
Ca
Mx
Li⁶-C²-cR²
Sd
C⁴-N³-B³
Landry Lake
Ca⁵-Mh⁵
Crossing Bay
LAK
Montreal L.
Ca
Ca⁶-B(P)⁴
C⁴-N³-B(P)³
At⁵-Li(s)³-Dr²
At⁵-Li(s)³-Dr²
Ca⁴-B(P)⁴-C²
Ca
Ca
Ca
Li
Sd⁶-Kt⁴
Sd
B(P)⁴-B³-N³
Ca⁵-B(P)³-B²
B(P)⁴-B³-N³
Ca
Mh⁶-Ca⁴
Driftwood Lake
Hw
Ca
Ca
P(P)
C⁴-N³-B(P)³
P(P)⁵-Ca⁵
Li(s)⁶-At³-cR¹
Ca
Little Kelsey Lake
Ca⁵-Mh⁵
Ca
Cut Line
Llx
Sd⁵-Mh⁵
C⁴-N³-B(P)³
Kc⁵-P(P)³-P²
Moose

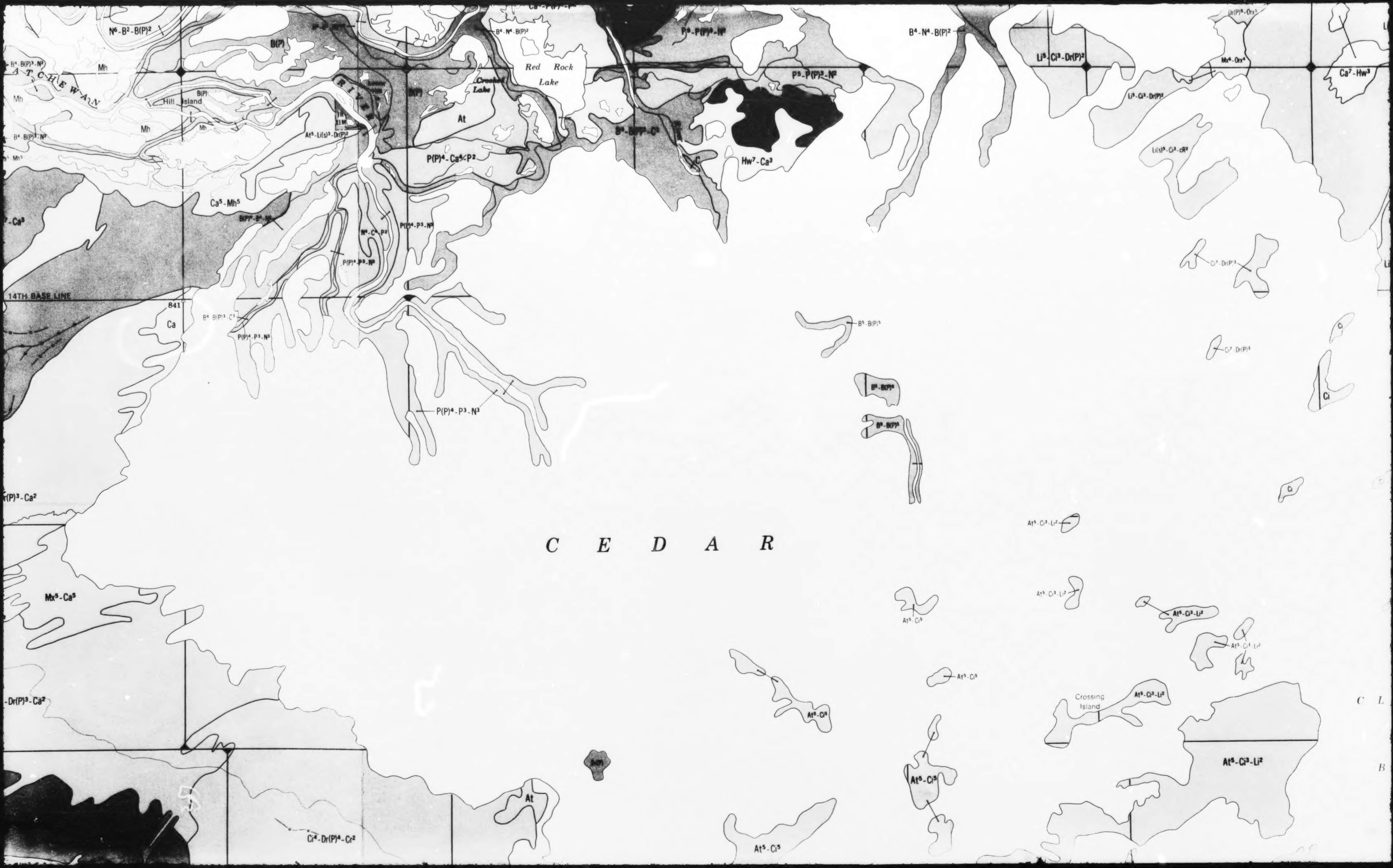


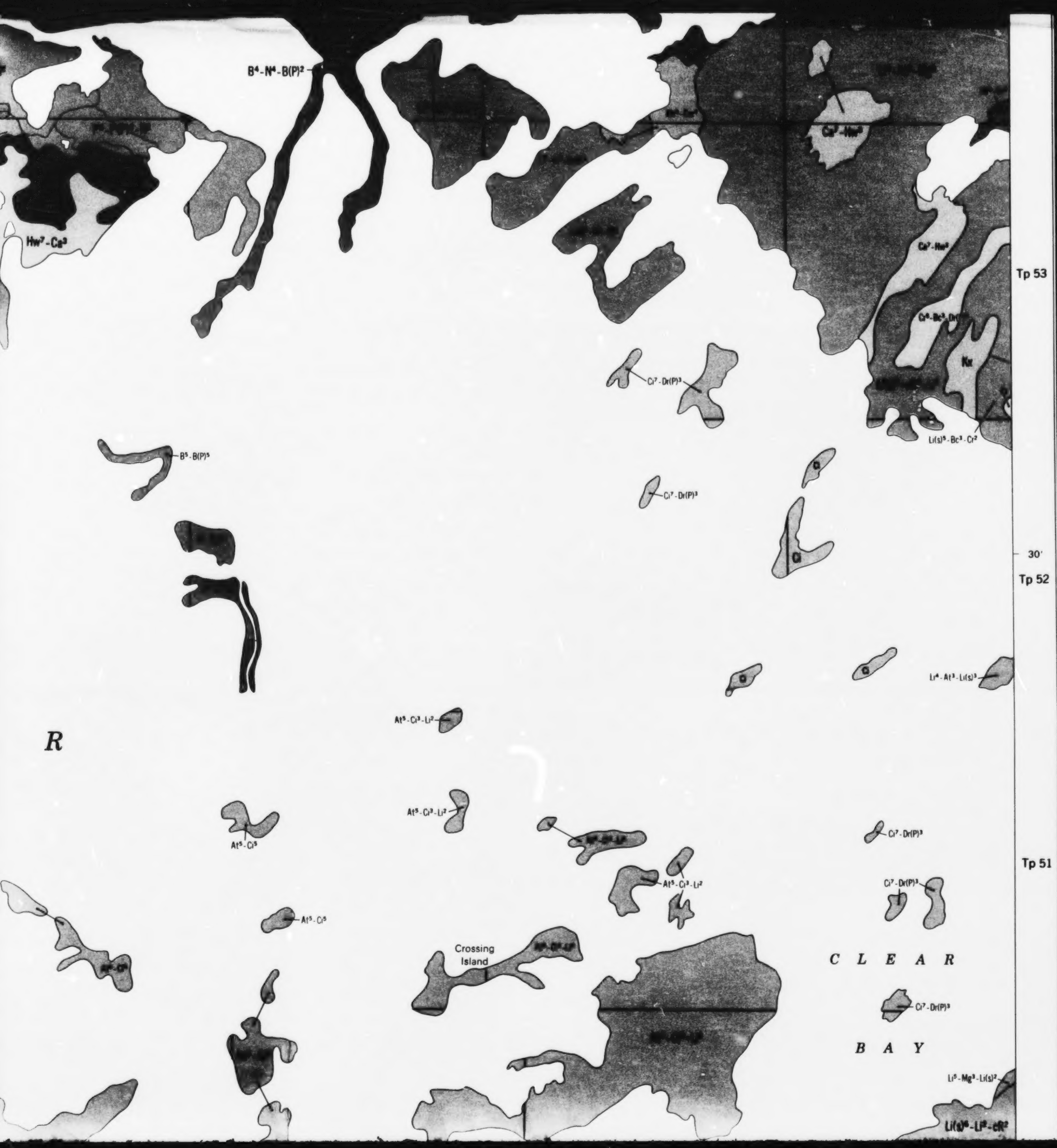
LEGEND

MAP SYMBOL	SOIL NAME AND DOMINANT SURFACE TEXTURE OR SURFACE PEAT MATERIAL	PROFILE TYPE	CLIMATIC ZONE MANITOBA ECOREGIONS (1) CSSC SOIL CLIMATE (2)	SURFICIAL GEOLOGY		NATURAL DRAINAGE	DOMINANT VEGETATION
				LANDFORM AND TOPOGRAPHY	SOIL MATERIAL		
■	Askandigau Series (clay)	Rego Gleysol	LB1 3.1-3.2 fe/b	Depressional to level, undulating moraine	0 to 15 cm of mesic peat overlying moderately to strongly calcareous, clayey, slightly stony till	Poor to very poor	Black spruce, balsam poplar, sedges and mosses
■	Askandigau Series (clay)	Rego Gleysol, peaty phase	LB1 3.1-3.2 fe/b	Depressional to level, undulating moraine	15 to 40 cm of mesic peat overlying moderately to strongly calcareous, clayey, slightly stony till	Poor to very poor	Some sedges, reed grasses and mosses
At	Atikameg Series (loam)	Eluviated Eutric Brunisol	LB1 3.1-3.2 fe/b	Level, undulating & ridged moraine	Extremely calcareous, loamy, very stony till	Well	Black spruce, jack pine, aspen
B	Big Lake Series (loam to clay loam)	Rego Gleysol, carbonated phase	LB4 3.1-3.2 fe/c	Depressional to level, fluvial flood plain	Moderately calcareous, fine loamy, recent alluvium	Poor to very poor	Reeds, sedges & willows
B(d)	Big Lake Series (loam to clay loam)	Rego Gleysol, drained carbonated phase	LB4 3.1-3.2 fe/c	Depressional to level, fluvial flood plain	Moderately calcareous, fine loamy, recent alluvium	Imperfect to poor	Reeds, sedges & willows
B(P)	Big Lake Series (loam to clay loam)	Rego Gleysol, peaty carbonated phase	LB4 3.1-3.2 fe/c	Depressional to level, fluvial flood plain	15 to 40 cm of mesic peat overlying moderately calcareous, fine loamy, recent alluvium	Poor to very poor	Reeds, sedges & willows
Bc	Birch Bay Series (loam)	Gleyed Eluviated Eutric Brunisol, carbonated, shallow and very shallow, lithic phases	LB1 3.1-3.2 fe/b	Morainal veneer overlying level to gently sloping bedrock	20 to 100 cm of extremely calcareous loamy, very stony till overlying limestone bedrock	Imperfect	Black spruce, aspen, willow
▨	Big Eddy Series, (clay)	Rego Gleysol, drained carbonated phase	LB4 3.1-3.2 fe/c	Depressional to level, fluvial flood plain	20 to 60 cm of moderately calcareous, clayey over sandy, recent alluvium	Imperfect to poor	Some reeds & sedges
C	Carrot Series (loam to clay loam)	Gleyed Cumulic Regosol	LB4 3.1-3.2 fe/c	Level to gently sloping, fluvial flood plain	Moderately calcareous, fine loamy, recent alluvium	Imperfect	Balsam poplar, elm, ash, aspen, white birch and white & black spruce
Ca	Cayer Series (mesic peat)	Terric Mesisol	LB1-HBt1 3.1-3.2 fe/b	Depressional to level, horizontal & ribbed fen	40 to 160 cm of mesic fen peat with little or no (< 15 cm) Sphagnum peat surface deposits. Underlain by strongly calcareous, loamy to clayey, stone-free lacustrine sediments	Very poor to poor	Sedges and mosses with clumps of stunted black spruce and tamarack
Chx	Chocolate Complex (fibric peat)	Terric Mesic Fibrisol* Terric Fibric Mesisol Terric Fibrisol	MB 3.1-3.2 fe/b	Level to depressional, blanket bog	Shallow (40-160 cm) organic soils with a thin to very thick (65-160 cm) continuous fibric Sphagnum peat surface layer overlying subdominant mesic forest and/or fen peat. Underlain by strongly calcareous, loamy to clayey, stone-free, lacustrine sediments	Poor to very poor	Stunted black spruce & tamarack with an understory of Sphagnum mosses & ericaceous shrubs
Ci	Chitek Series (loam)	Gleyed Eluviated Eutric Brunisol	LB1 3.1-3.2 fe/b	Level, undulating & ridged moraine	Extremely calcareous, loamy, very stony till	Imperfect	Black spruce, aspen, willow, jack pine
■	Cedar Lake Series (clay)	Orthic Gray Luvisol	LB1 3.1-3.2 fe/b	Gently undulating to undulating moraine	Moderately to strongly calcareous, clayey, slightly stony till	Well	Black spruce, white spruce, aspen, and some jack pine
Cp	Catfish Point Series (fibric peat)	Terric Mesic Fibrisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional, flat and blanket bog	Shallow (40-120 cm) organic soils with dominantly fibric Sphagnum and subdominant mesic layers	Poor to very poor	Black spruce, ericaceous shrubs and Sphagnum
cR	Carbonate Bedrock		LB1 3.1-3.2 fe/b	Level, gently sloping and terraced bedrock	0 to 10 cm of rock rubble overlying dolomite or dolomitic limestone bedrock	Rapid	Jack pine, black spruce & lichens
Cr	Crane Series (mesic peat)	Terric Mesisol	LB1-HBt1 3.1-3.2 fe/b	Depressional to level, horizontal & ribbed fen	40 to 160 cm of mesic fen peat with little or no (< 15 cm) Sphagnum surface peat deposits. Underlain by extremely calcareous, loamy, moderately stony till	Very poor to poor	Sedges and mosses with clumps of stunted black spruce and tamarack
■	Davis Point Series (clay)	Gleyed Dark Gray	HBt1 3.1-3.2 fe/b	Level to gently undulating moraine	Moderately to strongly calcareous, clayey, slightly stony till	Imperfect	Black spruce, aspen & balsam poplar
▨	Dering Series (loam)	Rego Gleysol, carbonated phase	LB1 3.1-3.2 fe/b	Depressional to level, undulating & ridged moraine	0 to 15 cm of mesic peat overlying extremely calcareous, loamy, moderately stony till	Poor	Black spruce, willows, ericaceous shrubs, feathermosses & Sphagnum
Dr(P)	Dering Series, (loam)	Rego Gleysol, peaty carbonated phase	LB1 3.1-3.2 fe/b	Depressional to level, undulating & ridged moraine	15 to 40 cm of mesic peat overlying extremely calcareous, loamy, moderately stony till	Poor	Black spruce, Labrador tea, Sphagnum and feathermosses
■	Duck River Series (loam)	Gleyed Dark Gray	HBt1 3.1-3.2 fe/b	Level to gently sloping, lacustrine	Extremely calcareous, loamy, lacustrine sediments	Imperfect	Balsam poplar, alder, & willow
Ea(P)	Easterville Series (sand and gravel)	Rego Gleysol, peaty carbonated phase	LB1 3.1-3.2 fe/b	Gently undulating to ridged lacustrine beach & outwash veneer overlying ridged moraine	15 to 40 cm of mesic peat overlying 25 to 100 cm of strongly calcareous, moderately stony, fragmental to sandy-skeltal deposits overlying extremely calcareous, loamy till	Poor	Black spruce, Labrador tea, Sphagnum and feathermosses
▨	Egg Island Series (clay)	Orthic Gray Luvisol, shallow lithic phase	LB1-HBt1 3.1-3.2 fe/b	Lacustrine veneer underlain by morainal veneer overlying level to gently sloping bedrock	Thin, moderately to strongly calcareous, clayey, stone-free, lacustrine deposits overlying extremely calcareous, loamy, very stony till. Limestone bedrock occurs within 50 to 100 cm of the surface	Well	Jack pine and black spruce
Fd	Fairford Series (loam)	Eluviated Eutric Brunisol	HBt1 3.1-3.2 fe/b	Level, undulating & ridged moraine	Extremely calcareous, loamy, very stony till	Well	Black spruce, aspen and jack pine
Fo	Foley Series (loam)	Rego Humic Gleysol, carbonated phase	HBt1 3.1-3.2 fe/b	Level, lacustrine	Extremely calcareous, loamy, lacustrine sediments	Poor	Willows, alders, feathermosses, sedges & grasses
[illegible]	Foley Series	Rego Humic Gleysol, peaty	HBt1	Level, lacustrine	15 to 40 cm of mesic peat	Poor	Willows, alders

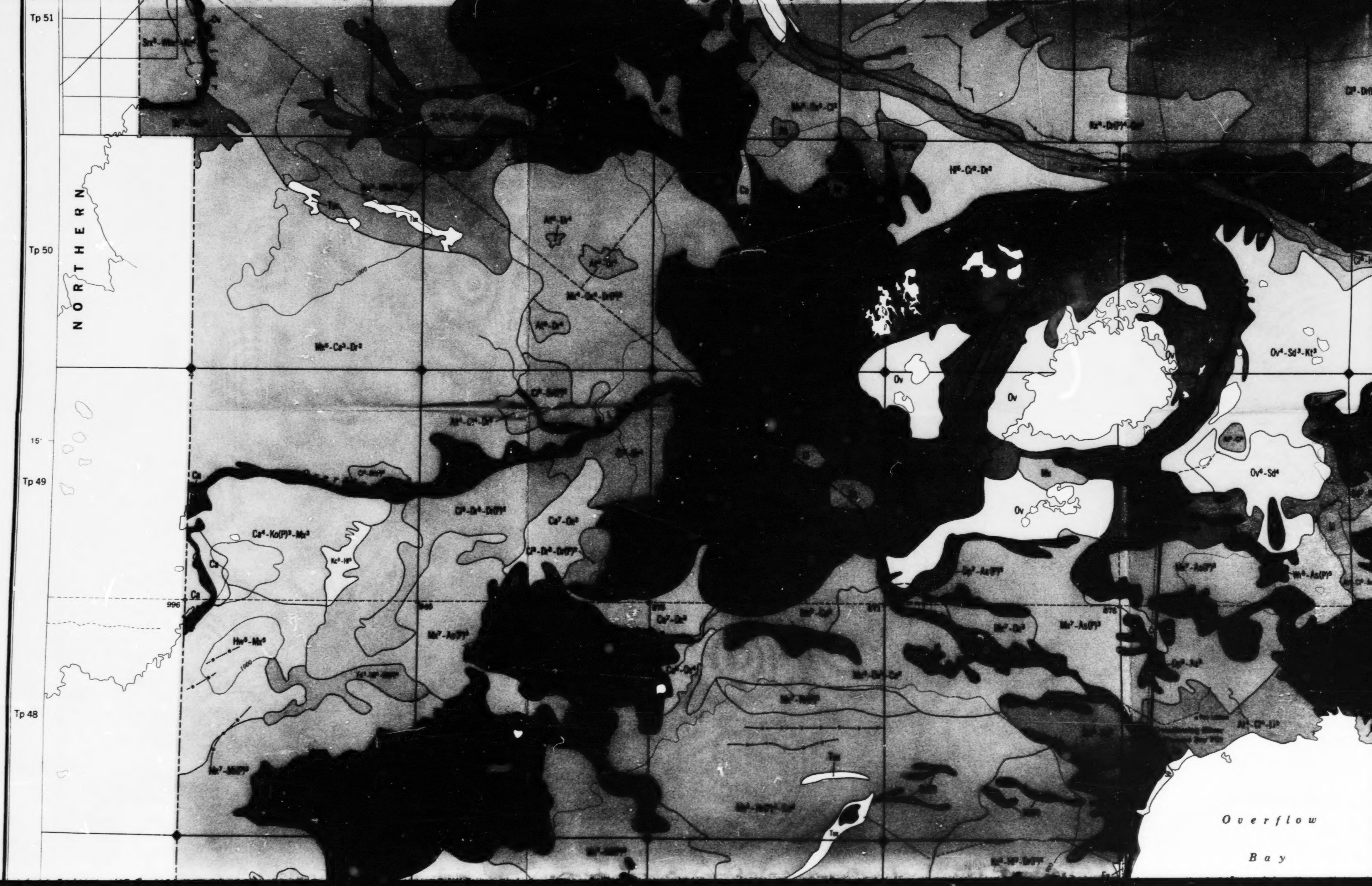


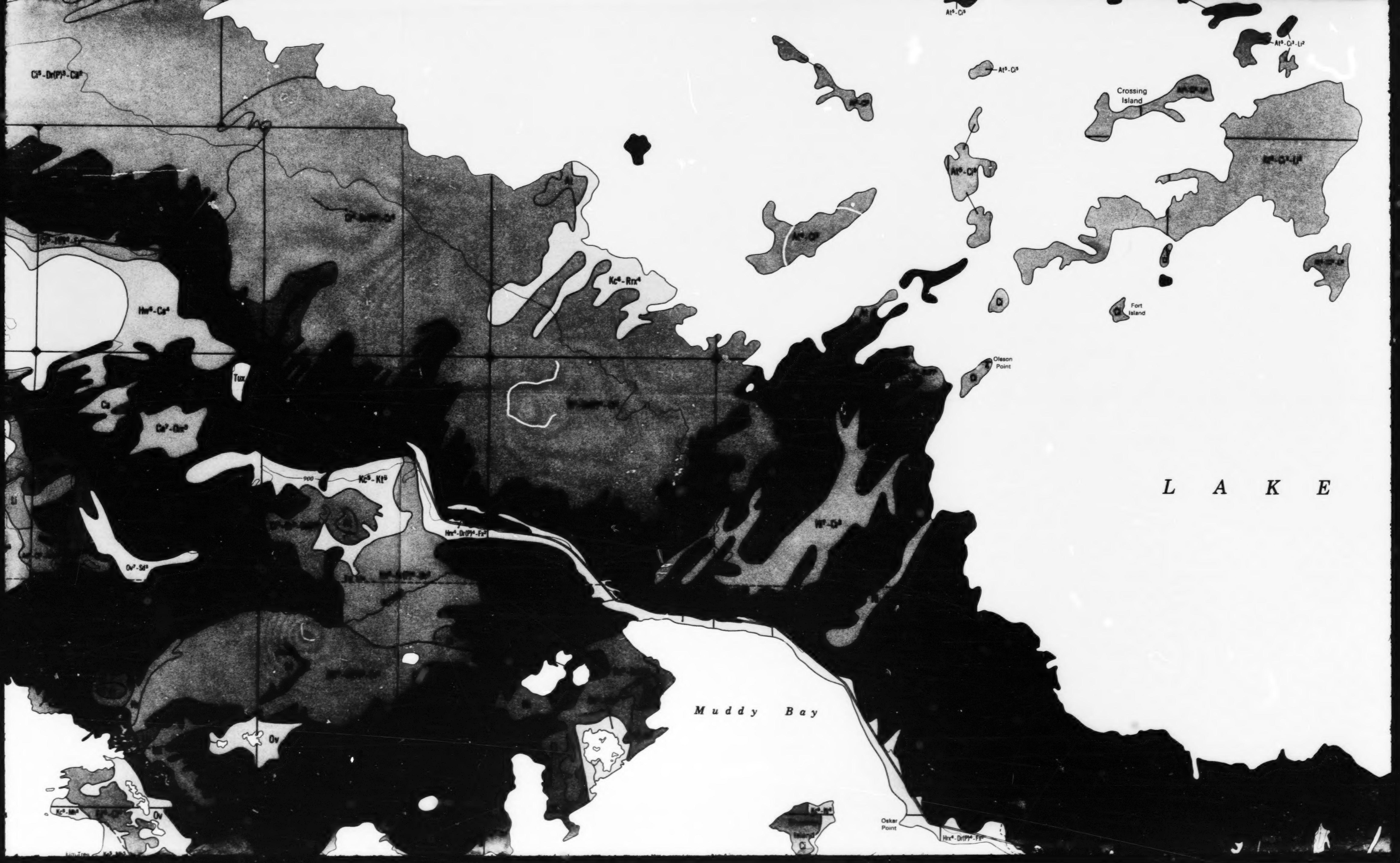
Culdesac Lake
Turnberry Lake
Tp 53
Tp 52
Tp 51
Tp 50
30
PROVINCIAL
THERN
SASKATCHEWAN
MANITOBA
Pasquia River
Lp⁶-Ca⁴
Wy
Sox
At
Askandigau Lake
Pasq
Lake
Ca
Cr⁷-Gd³
Mh
Ca⁵-Mh⁵
Lb⁷-Ca³
14TH BA
(At-Cl)⁴-Sox³-(Dr(P)-Ko(P))³
Hw⁷-Ca³
Ci
Sd⁶-Rrx²-Kc²
869
897
Kc⁷-Hw³
Mx⁵-Dr(P)³-Ci²
Nr(P)
1048
Sd
Sd⁶-Ca³
Ci⁵-Dr(P)³-Ca²
Ca⁶-Hw⁴
894
Nr(P)
Sd⁴-Kt⁴-Ov²
Ov⁷-Sd³
Ci⁵-Dr(P)³-Ca²
Mx⁵-Hw⁵
Srx⁵-Whx³-Kc²
Fx
Kx⁴-Dr(P)⁴-Ca²
Turnberry
Dv
Srx⁵-Whx³-Kc²
Sd⁷-Wsx³
Sd⁷-Kt³
Srx⁵-Whx³-Kc²
Sd⁵-Wsx³
Srx⁵-Whx³-Kc²
Tux
Mx
Mx⁵-Ox³-Ci²
At
1000
Ci²-Fx³-Hrx³
10
Ky⁴-Dr(P)⁴-Ca²
Ci⁵-Dr(P)³-Ci
Ci⁵-Dr(P)³
Hl⁶-Cr²-Dr²
Ci⁴-Fx³-Hrx³
At⁶-Dr⁴
At⁶-Dr⁴
Sd⁶-Ov⁴
Sd⁵-Kt³-Ca²
Ci⁶-Hrx²

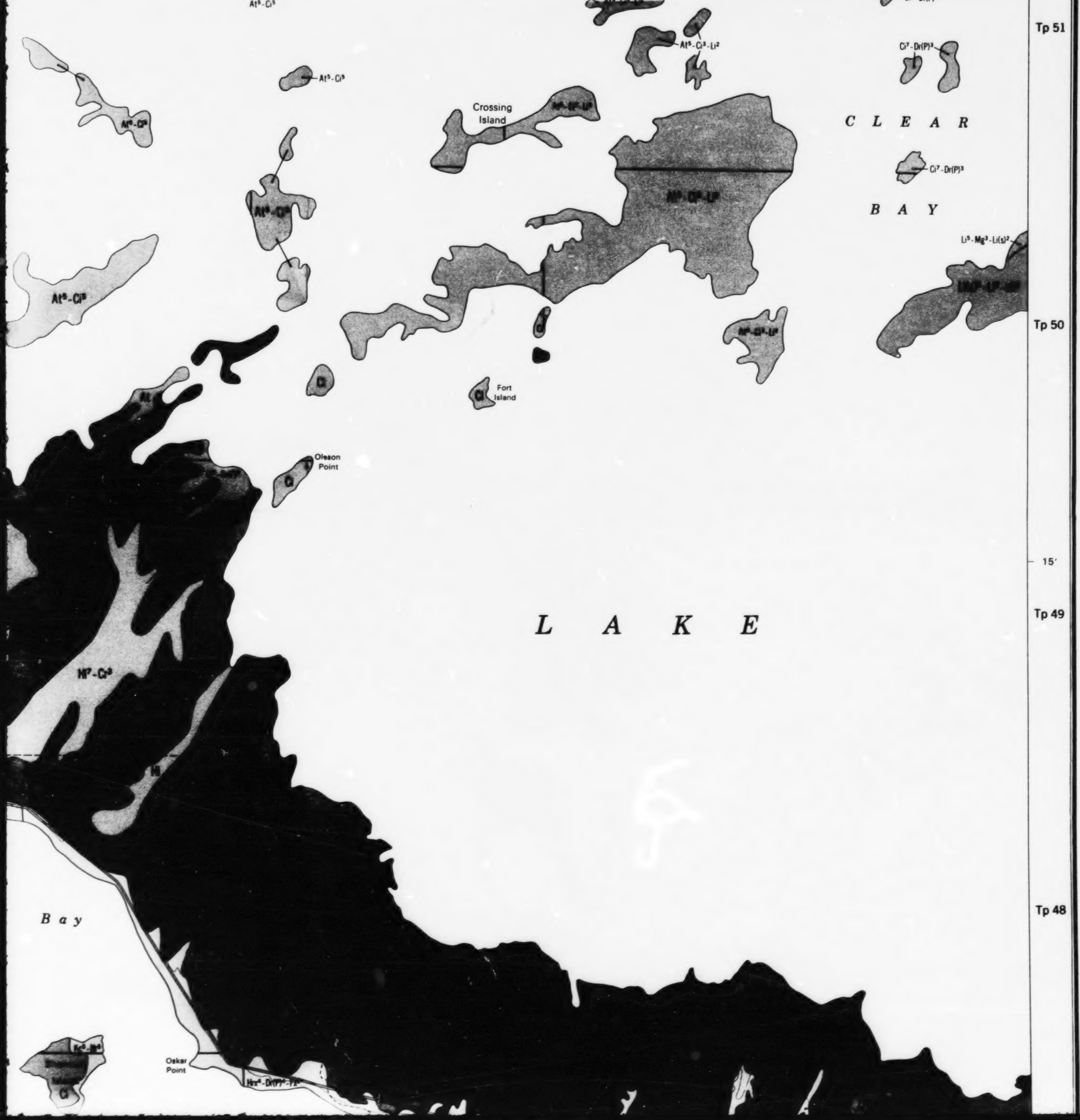

$N^{6}-B^{2}-B(P)^{2}$
$B^{4}-B(P)^{3}-N^{3}$
SASKATCHEWAN RIVER
Mh
B(P)
Hill Island
$B^{4}-B(P)^{3}-N^{3}$
$At^{5}-Li(s)^{3}-Dr(P)^{2}$
$Ca^{5}-Mh^{5}$
$B(P)^{4}-B^{4}-N^{2}$
Ca^{3}
$B^{4}-N^{4}-B(P)^{2}$
Red Rock Lake
Crooked Lake
At
$P(P)^{4}-Ca^{4}-P^{2}$
$P(P)^{4}-P^{3}-N^{3}$
$N^{4}-C^{4}-P^{2}$
14TH BASE LINE
841
Ca
$B^{4}-B(P)^{3}-C^{3}$
$P^{6}-P(P)^{6}-N^{6}$
$P^{5}-P(P)^{3}-N^{2}$
$B^{6}-B(P)^{3}-C^{3}$
C
$Hw^{7}-Ca^{3}$
$Li^{5}-Ci^{3}-Dr(P)^{2}$
$Dr(P)^{5}-Orx^{5}$
$Mx^{6}-Orx^{4}$
$Ca^{7}-Hw^{3}$
$Li(s)^{5}-Ci^{3}-cR^{2}$
$Ci^{7}-Dr(P)^{3}$
$B^{5}-B(P)^{5}$
Ci
CEDAR
$Dr(P)^{3}-Ca^{2}$
$Mx^{5}-Ca^{5}$
$At^{5}-Ci^{3}-Li^{2}$
$At^{5}-Ci^{5}$
Crossing Island
B(P)
$Ci^{4}-Dr(P)^{4}-Cr^{2}$
C
L
B



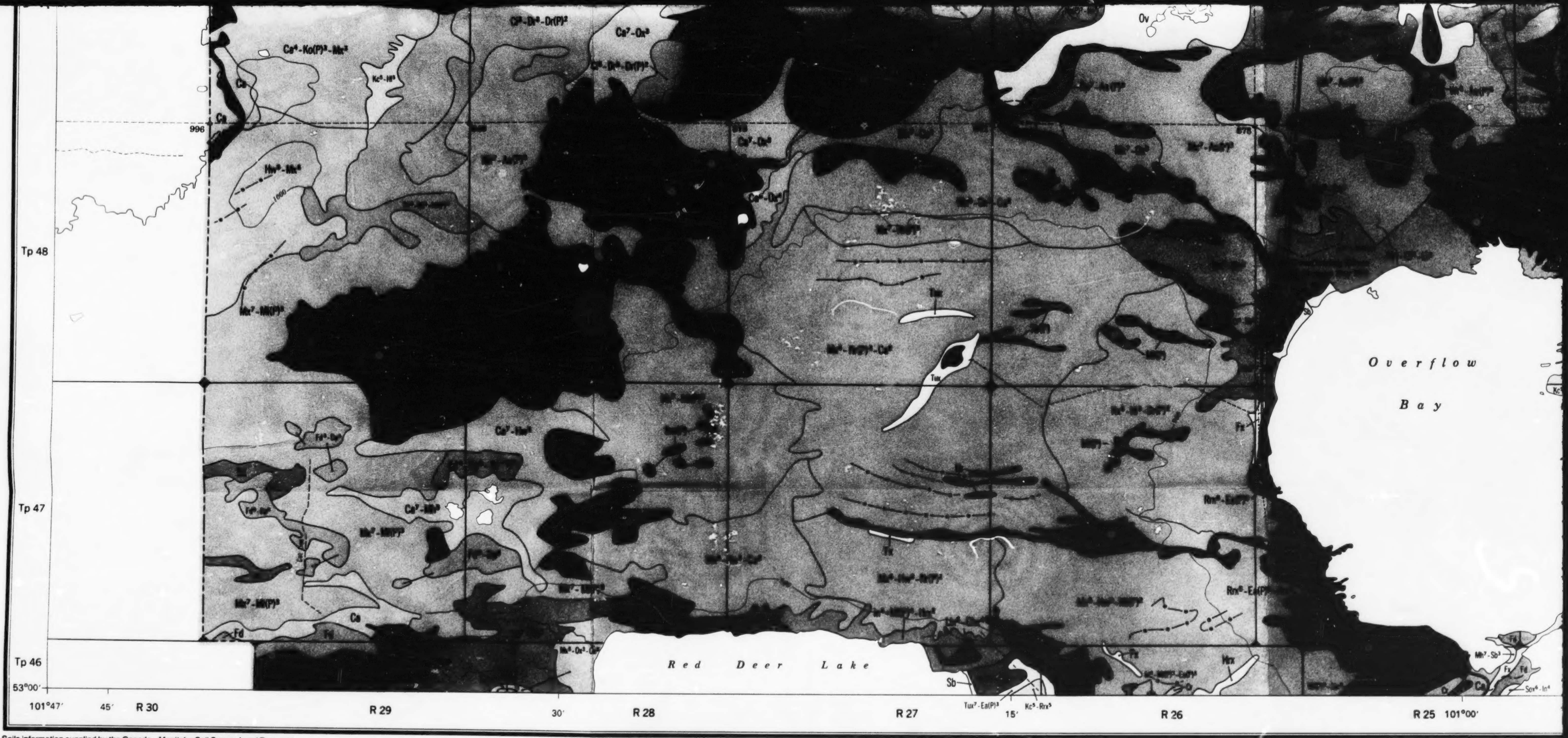
		Terric Mesic Fibrisol Terric Fibric Mesisol			Underlain by strongly calcareous, sandy sediments.		Sphagnum and feathermosses
■	Homebrook Series (clay)	Orthic Dark Gray	HBt1 3.1-3.2 fe/b	Gently undulating to undulating moraine	Moderately to strongly calcareous, clayey, slightly stony till.	Well	Black spruce, white spruce, aspen and balsam poplar
Hl	Halcrow Series (mesic peat)	Terric Mesisol, sphagnic phase	LB1-HBt1 3.1-3.2 fe/b	Depressional to level, horizontal fen	Shallow (40-160 cm) mesic fen peat with a very thin (15-65 cm) fibric Sphagnum peat surface layer. Underlain by extremely calcareous, loamy, moderately stony till.	Very poor to poor	Stunted black spruce and tamarack with an understory of Sphagnum, sedges, and ericaceous shrubs
■	Homestead Series (loam)	Gleyed Cumulic Regosol	HBt1 3.1-3.2 fe/b	Level lacustrine	Moderately to strongly calcareous, loamy, recent alluvium.	Imperfect	Birch, ash, elm, white spruce & aspen
Hrx	Horseshoe Island Complex (sand and gravel)	Gleyed Eluviated Eutric Brunisol* Gleyed Gray Luvisol	LB1-HBt1 3.1-3.2 fe/b	Ridged lacustrine beach and outwash veneer overlying ridged moraine	25 to 100 cm of strongly calcareous, stratified, moderately calcareous, fragmental to sandy-skeletal deposits overlying extremely calcareous, loamy till.	Imperfect	Black spruce, jack pine, aspen
Hw	Howell Series (mesic peat)	Terric Mesisol, sphagnic phase	LB1-HBt1 3.1-3.2 fe/b	Depressional to level, horizontal fen	Shallow (40-160 cm) mesic fen peat with a very thin (15-65 cm) fibric Sphagnum peat surface layer. Underlain by strongly calcareous, loamy to clayey, stone-free, lacustrine sediments.	Very poor to poor	Stunted black spruce and tamarack with an understory of Sphagnum, sedges and ericaceous shrubs
In	Inwood Series (loam)	Gleyed Dark Gray	HBt1 3.1-3.2 fe/b	Level, undulating & ridged moraine	Extremely calcareous, loamy, very stony till.	Imperfect	Black spruce, aspen, willow
Kc	Kircro Series (mesic peat)	Terric Mesisol	LB1-HBt1 3.1-3.2 fe/b	Depressional to level, horizontal & ribbed fen	Shallow (40-160 cm) mesic fen peat with little or no (< 15 cm) Sphagnum surface peat deposits. Underlain by strongly calcareous, sandy sediments.	Very poor	Sedges and mosses with clumps of stunted black spruce and tamarack
■	Kinwow Series (clay)	Orthic Gray Luvisol	LB1 3.1-3.2 fe/b	Level to undulating lacustrine veneer overlying undulating moraine	15 to 100 cm of moderately to strongly calcareous, clayey, stone-free lacustrine sediments overlying extremely calcareous, loamy, very stony till.	Well	Black spruce, aspen, and jack pine
■	Koostatak Series (clay)	Rego Humic Gleysol	LB1 3.1-3.2 fe/b	Depressional to level lacustrine	Moderately to strongly calcareous, clayey stonefree lacustrine sediments.	Poor	Willows, alders, sedges and reeds
■	Koostatak Series, (clay)	Rego Humic Gleysol, peaty phase	LB1 3.1-3.2 fe/b	Depressional to level lacustrine	15 to 40 cm of mesic peat overlying moderately to strongly calcareous, clayey, stonefree lacustrine sediments.	Poor	Willows, alders, sedges and reeds
■	Katimik Series (mesic peat)	Typic Mesisol, sphagnic phase	LB1-HBt1 3.1-3.2 fe/b	Depressional to level horizontal fen	Deep (> 160 cm) mesic fen peat with a very thin (15-65 cm) fibric Sphagnum peat surface layer. Underlain by undifferentiated materials.	Poor to very poor	Stunted black spruce and tamarack with an understory of dominantly Sphagnum moss and ericaceous shrubs
Kx	Kilkenny Complex (fibric peat)	Terric Mesic Fibrisol* Terric Fibric Mesisol Terric Fibrisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional blanket bog	Shallow (40-160 cm) organic soils with a thin to very thick (65-160 cm) continous fibric Sphagnum peat surface layer overlying subdominant mesic forest or fen peat. Underlain by extremely calcareous, loamy, moderately stony till.	Poor to very poor	Black spruce, Sphagnum moss and ericaceous shrubs
Li	Limestone Point Series (loam)	Eluviated Eutric Brunisol, shallow and very shallow lithic phases	LB1 3.1-3.2 fe/b	Morainal veneer overlying level to gently sloping bedrock	20 to 100 cm of extremely calcareous, loamy, very stony till overlying limestone bedrock.	Well	Black spruce, jack pine and aspen
Li(s)	Limestone Point Series	Eluviated Eutric Brunisol, extremely shallow lithic phase	LB 3.1-3.2 fe/b	Morainal veneer overlying level to gently sloping bedrock	10 to 20 cm of extremely calcareous, loamy, moderately rocky till overlying limestone bedrock.	Well	Jack pine, black spruce, aspen
■	Lamb Lake Complex (mesic peat)	Terric Mesisol, sphagnic phase* Terric Mesisol Terric Fibric Mesisol Terric Mesic Fibrisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional, flat and blanket bog	Shallow (40-160 cm) mesic forest peat with a very thin (<65 cm) fibric Sphagnum peat surface layer. Underlain by extremely calcareous, loamy, moderately stony till.	Poor to very poor	Black spruce, Sphagnum moss & ericaceous shrubs
■	Le Pas Series (clay)	Rego Gleysol, carbonated phase	LB4 3.1-3.2 fe/c	Depressional to level fluvial flood plain	Moderately calcareous, clayey, recent alluvium.	Poor to very poor	Sedges and reeds
■	Lettonia Series (clay)	Solonetzic Gray Luvisol	LB1 3.1-3.2 fe/b	Level to undulating lacustrine sediments	Moderately to strongly calcareous, clayey, stone-free, lacustrine sediments.	Well	Spruce, aspen & jack pine
■	Mantagao Series (clay)	Gleyed Gray Luvisol	LB1 3.1-3.2 fe/b	Level to undulating lacustrine veneer overlying undulating moraine	15 to 100 cm of moderately to strongly calcareous, clayey, stone-free lacustrine deposits overlying extremely calcareous, loamy, very stony till.	Imperfect	Black spruce, aspen, balsam poplar & willow
Mh	Marsh	Rego Gleysol	All zones	Depressional to level moraine & lacustrine	Dominantly extremely calcareous, loamy till, significant clayey veneer.	Very poor	Reed grasses & sedges
Ml	Meleb Series (loam)	Rego Humic Gleysol, carbonated phase	HBt1 3.1-3.2 fe/b	Depressional to level, undulating & ridged moraine	Extremely calcareous, loamy, moderately stony till.	Poor	Meadow grasses, sedges, alders & willows
■	Meleb Series (loam)	Rego Humic Gleysol, peaty carbonated phase	HBt1 3.1-3.2 fe/b	Depressional to level, undulating & ridged moraine	15 to 40 cm of mesic peat overlying extremely calcareous, loamy, moderately stony till.	Poor	Sedges, meadow grasses, willow, swamp birch, balsam poplar, aspen, black spruce
■	Mukatawa Series (clay)	Gleyed Solonetzic Gray Luvisol	LB1 3.1-3.2 fe/b	Level to undulating, lacustrine sediments	Moderately to strongly calcareous, clayey, stone-free, lacustrine sediments.	Imperfect	Black spruce, aspen
■	Molson Complex (fibric peat)	Terric Mesic Fibrisol* Terric Fibric Mesisol Terric Fibrisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional blanket bog	Shallow (40-160 cm) organic soils with a thin to very thick (65-160 cm) continuous fibric Sphagnum peat surface layer overlying subdominant mesic forest and/or fen peat. Underlain by strongly calcareous, clayey, stone-free, lacustrine sediments.	Poor to very poor	Black spruce, Sphagnum and ericaceous shrubs
■	Nels Series (loam)	Gleyed Cumulic Regosol	LB4 3.1-3.2 fe/c	Level to gently sloping, fluvial flood plain	Moderately calcareous, coarse loamy, recent alluvium.	Imperfect	Aspen, balsam poplar, willow & black spruce
Nb(P)	Napanee Bay Series, (clay)	Rego Humic, Gleysol, peaty phase	LB1 3.1-3.2 fe/b	Depressional to level lacustrine veneer overlying undulating moraine	15 to 100 cm of moderately to strongly calcareous, clayey, stone-free, lacustrine sediments overlying extremely calcareous, loamy, very stony till.	Poor	Black spruce, Labrador tea, Sphagnum and feathermosses
	Nekik Lake Complex	Mesic Organic Cryosol*	MB	Level, domed or	Deep perennially frozen forest peat, or	Well to	Black spruce,


Tp 51
Tp 50
Tp 49
Tp 48
15'
N O R T H E R N
Mx5-Ca3-Dr2
Ca4-Ko(P)3-Mx3
Kc3-H3
Hw6-Mx5
Ca
996
1000
Tm
Ca7-Dr6
Mx7-As(P)3
H6-Cr2-Dr2
Ov
Ov4-Sd3-Kt3
Ov6-Sd4
Mx
Overflow
Bay


At⁵-Ci⁵
At⁵-Ci³-Li²
At⁵-Ci⁵
Crossing Island
Ci⁵-Dr(P)³-Ca³
At⁵-Ci⁵
Kc⁶-Rrx⁴
Hw⁵-Ca⁴
Ci
Fort Island
Oleson Point
Tux
Ca
Ca⁷-Gm³
900
Kc⁵-Kt⁵
Hrx⁴-Dr(P)⁴-Fr²
Wl⁶-Ci⁴
L A K E
Ov⁷-Sd³
Muddy Bay
Ov
Ov
Ci
Oskar Point
Hrx⁴-Dr(P)⁴-Fr²



				moraine	calcareous, loamy, very stony till		
Mh	Marsh	Rego Gleysol	All zones	Depressional to level moraine & lacustrine	Dominantly extremely calcareous, loamy till, significant clayey veneer	Very poor	Reed grasses & sedges
Ml	Meleb Series (loam)	Rego Humic Gleysol, carbonated phase	HBt1 3.1-3.2 fe/b	Depressional to level, undulating & ridged moraine	Extremely calcareous, loamy, moderately stony till	Poor	Meadow grasses, sedges, alders & willows
■	Meleb Series (loam)	Rego Humic Gleysol, peaty carbonated phase	HBt1 3.1-3.2 fe/b	Depressional to level, undulating & ridged moraine	15 to 40 cm of mesic peat overlying extremely calcareous, loamy, moderately stony till	Poor	Sedges, meadow grasses, willow, swamp birch, balsam poplar, aspen, black spruce
■	Mukatawa Series (clay)	Gleyed Solonetzic Gray Luvisol	LB1 3.1-3.2 fe/b	Level to undulating, lacustrine sediments	Moderately to strongly calcareous, clayey, stone-free, lacustrine sediments.	Imperfect	Black spruce, aspen
▨	Molson Complex (fibric peat)	Terric Mesic Fibrisol* Terric Fibric Mesisol Terric Fibrisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional blanket bog	Shallow (40-160 cm) organic soils with a thin to very thick (65-160 cm) continuous fibric Sphagnum peat surface layer overlying subdominant mesic forest and/or fen peat. Underlain by strongly calcareous, clayey, stone-free, lacustrine sediments	Poor to very poor	Black spruce, Sphagnum and ericaceous shrubs
▨	Nels Series (loam)	Gleyed Cumulic Regosol	LB4 3.1-3.2 fe/c	Level to gently sloping, fluvial flood plain	Moderately calcareous, coarse loamy, recent alluvium.	Imperfect	Aspen, balsam poplar, willow & black spruce
Nb(P)	Napanee Bay Series, (clay)	Rego Humic, Gleysol, peaty phase	LB1 3.1-3.2 fe/b	Depressional to level lacustrine veneer overlying undulating moraine	15 to 100 cm of moderately to strongly calcareous, clayey, stone-free, lacustrine sediments overlying extremely calcareous, loamy, very stony till	Poor	Black spruce, Labrador tea, Sphagnum and feathermosses
Nlx	Nekik Lake Complex (frozen mesic peat)	Mesic Organic Cryosol* Fibric Organic Cryosol	MB 3.1 b/e	Level, domed or ridged peat plateau & palsas	Deep perennially frozen forest peat, or thin Sphagnum peat overlying frozen mesic forest peat.	Well to imperfect	Black spruce, with an understory of Cladonia, Labrador tea, & feathermosses
No	Novra Series (loam)	Rego Gleysol	HBt1 3.1-3.2 fe/b	Level, lacustrine	Moderately to strongly calcareous, loamy, recent alluvium.	Poor	Willows, alders, feathermosses, sedges & grasses
■	Novra Series, (loam)	Rego Gleysol, peaty phase	HBt1 3.1-3.2 fe/b	Level, lacustrine	15 to 40 cm of mesic peat overlying moderately to strongly calcareous, loamy, recent alluvium.	Poor	Willows, alders, feathermosses, sedges and grasses
▨	Norris Series (sand and gravel)	Rego Gleysol, carbonated phase	LB1 3.1-3.2 fe/b	Gently undulating to ridged lacustrine beach and outwash	Stratified, calcareous, moderately stony, sandy-skeletal deposits.	Poor	Black spruce, Labrador tea, & feathermosses
▨	Norris Series, (sand and gravel)	Rego Gleysol, peaty carbonated phase	LB1-HBt1 3.1-3.2 fe/b	Gently undulating to ridged lacustrine beaches and outwash	15 to 40 cm of mesic peat overlying stratified, calcareous, moderately stony, sandy-skeletal deposits.	Poor	Black spruce, Labrador tea, & feathermosses
■	Orok Complex (mesic peat)	Terric Mesisol, sphagnic phase* Terric Mesisol Terric Fibric Mesisol Terric Mesic Fibrisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional flat & blanket bog	Shallow (40-160 cm) mesic forest peat with a very thin (<65 cm) fibric Sphagnum peat surface layer. Underlain by strongly calcareous, loamy to clayey, stone-free lacustrine sediments.	Poor to very poor	Black spruce, Sphagnum and ericaceous shrubs
■	Okno Complex (mesic peat)	Terric Mesisol* Terric Mesisol, sphagnic phase Terric Fibric Mesisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional flat bog	Shallow (40-160 cm) mesic forest peat, with (<65 cm) discontinuous fibric Sphagnum peat overlying mesic forest peat. Underlain by strongly calcareous, loamy to clayey, stone-free, lacustrine sediments	Poor to very poor	Black spruce, Sphagnum and feathermosses, & ericaceous shrubs
Ov	Overflowing Series (mesic peat)	Typic Mesisol, aquic phase	LB1 3.1-3.2 fe/b	Depressional to level, horizontal & ribbed fen	Deep (>160 cm) mesic fen peat with a hydric or semifluid layer occurring between 40-130 cms. Underlain by undifferentiated materials.	Very poor	Sedges and mosses
▨	Pasquia Series (sandy loam)	Rego Gleysol, carbonated phase	LB4 3.1-3.2 fe/c	Depressional to level flood plain	Moderately calcareous, coarse loamy, recent alluvium.	Poor to very poor	Sedges, reeds, willows, and some aspens
▨	Pasquia Series, (sandy loam)	Rego Gleysol, drained carbonated phase	LB4 3.1-3.2 fe/c	Depressional to level flood plain	Moderately calcareous, coarse loamy, recent alluvium.	Imperfect to poor	Sedges, reeds, willows, and some aspens
▨	Pasquia Series, (sandy loam)	Rego Gleysol, peaty carbonated phase	LB4 3.1-3.2 fe/c	Depressional to level flood plain	15 to 40 cm of mesic peat overlying moderately calcareous, coarse loamy, recent alluvium	Poor to very poor	Sedges, reeds, willows, and some aspens
Rex	Reed Lake Complex (mesic peat)	Terric Mesisol* Terric Mesisol, sphagnic phase	MB 3.1 b/e	Depressional to level horizontal and ribbed fen	Shallow (40-160 cm) mesic fen peat or little or no (< 15 cm) fibric Sphagnum peat overlying mesic forest peat. Underlain by strongly calcareous, loamy to clayey, stone-free lacustrine sediments.	Very poor to poor	Sedges and mosses with clumps of stunted black spruce and tamarack
■	Rock Island Complex (mesic peat)	Typic Mesisol* Typic Mesisol, sphagnic phase	MB 3.1 b/e	Depressional to level horizontal and ribbed fen	Deep (>160 cm) mesic fen peat, or little or no (< 15 cm) fibric Sphagnum peat overlying mesic fen peat. Underlain by undifferentiated materials.	Very poor	Sedges, mosses, swamp birch & tamarack
■	Rat River Complex (mesic peat)	Terric Mesisol* Terric Mesisol, sphagnic phase Terric Fibric Mesisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional flat bog	Shallow (40-160 cm) mesic forest peat with (< 65 cm) discontinuous fibric Sphagnum peat overlying mesic forest peat. Underlain by strongly calcareous sandy-skeletal sediments.	Poor to very poor	Black spruce, Sphagnum and feathermosses, & ericaceous shrubs
Sb	Sand Beaches (sand)	Orthic Regosol	LB1 3.1-3.2 fe/b -3.1 b/e	Ridged lacustrine beach deposits	Stratified, calcareous, sandy-skeletal deposits of recent origin	Well to imperfect	Scattered aspen, balsam poplar and willow
■	Stead Series (mesic peat)	Typic Mesisol	LB1-HBt1 3.1-3.2 fe/b	Depressional to level horizontal and ribbed fen	Deep (>160 cm) mesic fen peat or little or no (<15 cm) fibric Sphagnum peat overlying mesic fen peat. Underlain by undifferentiated materials.	Very poor	Sedges, mosses, swamp birch, & tamarack
■	Swanford Series (loam)	Gleyed Rego Black	HBt1 3.1-3.2 fe/b	Level to very gently sloping lacustrine	Strongly calcareous, loamy, lacustrine sediments.	Imperfect	Aspen, balsam poplar, spruce, willow & grasses
■	Saline Flats	Rego Gleysol, saline phase	LB1 3.1-3.2 fe/b	Level to very gently sloping lacustrine	Exposed lake flats of extremely calcareous, loamy, very stony till.	Poor to very poor	Odd salt tolerant plants
■	Sagemace Series, (clay)	Rego Humic Gleysol, peaty phase	HBt1 3.1-3.2 fe/b	Depressional to level, gently undulating moraine	15 to 40 cm of mesic peat overlying moderately to strongly calcareous, clayey, slightly stony till.	Poor	Black spruce, willow, sedges & meadow grasses
Sox	Soul Lake Complex (sand and gravel)	Eluviated Eutric Brunisol* Orthic Gray Luvisol Orthic Eutric Brunisol	LB1 3.1-3.2 fe/b	Ridged lacustrine beach and outwash veneer overlying ridged moraine	25 to 100 cm of strongly calcareous, stratified, moderately stony, fragmental to sandy-skeletal deposits overlying extremely calcareous, loamy till.	Well	Jack pine, aspen and black spruce
Srx	Sand River Complex (fibric peat)	Terric Mesic Fibrisol* Terric Fibric Mesisol Terric Fibrisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional blanket bog	Shallow (40-160 cm) organic soils with a thin to very thick (65-160 cm) continuous fibric Sphagnum peat layer	Poor to very poor	Black spruce, Sphagnum and ericaceous



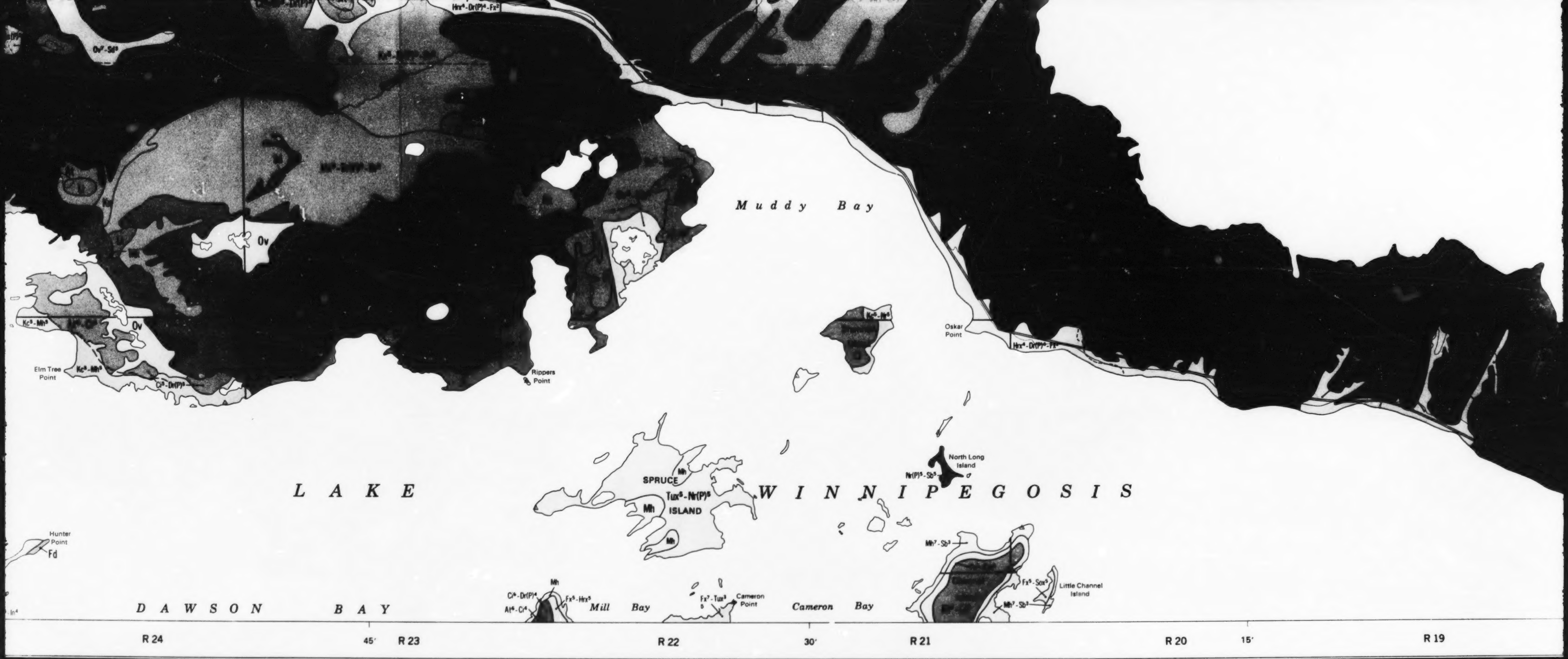
Soils information supplied by the Canada – Manitoba Soil Survey, Land Resource Research Institute, Agriculture Canada; Land Utilization Branch, Manitoba Department of Agriculture and Soils Department, University of Manitoba.

Soil boundary
Main highway
Secondary road
Other roads
Cart track
Trail
Railway
Power transmission line
Township and Range line

Section line
Indian reserve boundary
Stream, perennial
Drainage ditch
Spot elevation 287.
Town
Horizontal control point
Contour interval (100 feet) 400 500
Depression contour

THE

Kilometres 2 1/2 0
Miles 2 1 0



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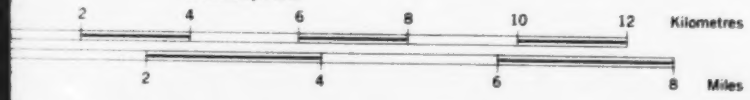


KEY MAP

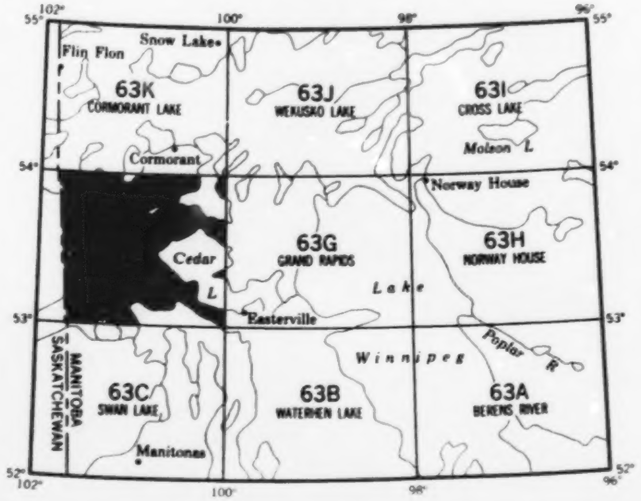
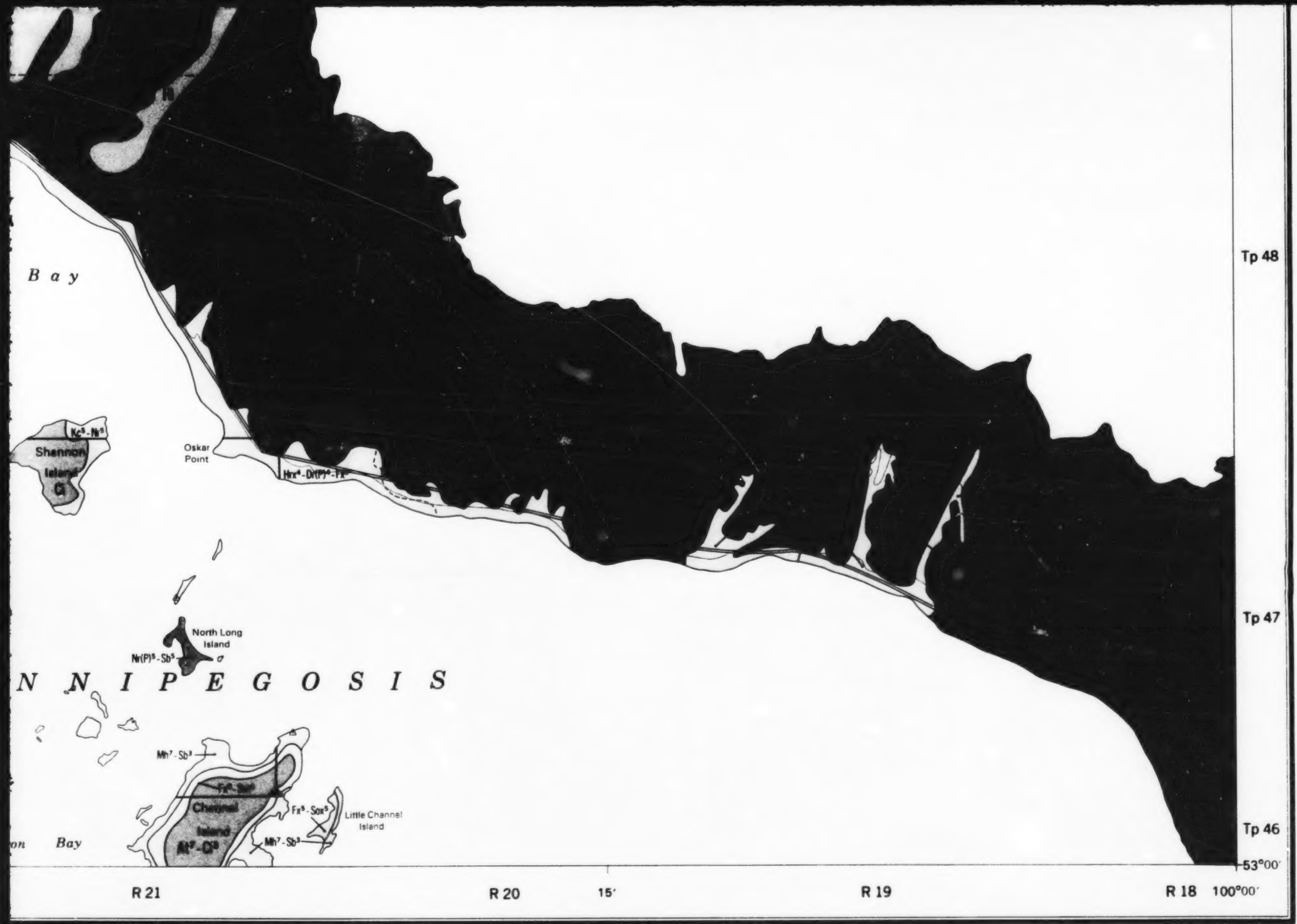


DIAGRAM OF TOWNSHIP

31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1

Cartography by the Land Re
Agriculture Canada, 1981
Printing supplied by the M
Distribution Division, Departm



	(sandy loam)	(carbonated phase)	3.1-3.2 fe/b	flood plain	moderately calcareous coarse loamy recent alluvium	very poor	willows and some aspens
Rex	Reed Lake Complex (mesic peat)	Terric Mesisol* Terric Mesisol, sphagnic phase	MB 3.1 b/e	Depressional to level horizontal and ribbed fen	Shallow (40-160 cm) mesic fen peat or little or no (< 15 cm) fibric Sphagnum peat overlying mesic forest peat. Underlain by strongly calcareous, loamy to clayey, stone-free lacustrine sediments	Very poor to poor	Sedges and mosses with clumps of stunted black spruce and tamarack
	Rock Island Complex (mesic peat)	Typic Mesisol* Typic Mesisol, sphagnic phase	MB 3.1 b/e	Depressional to level horizontal and ribbed fen	Deep (>160 cm) mesic fen peat, or little or no (< 15 cm) fibric Sphagnum peat overlying mesic fen peat. Underlain by undifferentiated materials	Very poor	Sedges, mosses, swamp birch & tamarack
	Rat River Complex (mesic peat)	Terric Mesisol* Terric Mesisol, sphagnic phase Terric Fibric Mesisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional flat bog	Shallow (40-160 cm) mesic forest peat with (< 65 cm) discontinuous fibric Sphagnum peat overlying mesic forest peat. Underlain by strongly calcareous sandy-skeletal sediments	Poor to very poor	Black spruce, Sphagnum and feathermosses, & ericaceous shrubs
Sb	Sand Beaches (sand)	Orthic Regosol	LB1 3.1-3.2 fe/b -3.1 b/e	Ridged lacustrine beach deposits	Stratified, calcareous, sandy-skeletal deposits of recent origin	Well to imperfect	Scattered aspen, balsam poplar and willow
	Stead Series (mesic peat)	Typic Mesisol	LB1-HBt1 3.1-3.2 fe/b	Depressional to level horizontal and ribbed fen	Deep (>160 cm) mesic fen peat or little or no (< 15 cm) fibric Sphagnum peat overlying mesic fen peat. Underlain by undifferentiated materials	Very poor	Sedges, mosses, swamp birch, & tamarack
	Swanford Series (loam)	Gleyed Rego Black	HBt1 3.1-3.2 fe/b	Level to very gently sloping lacustrine	Strongly calcareous, loamy, lacustrine sediments	Imperfect	Aspen, balsam poplar, spruce, willow & grasses
	Saline Flats	Rego Gleysol, saline phase	LB1 3.1-3.2 fe/b	Level to very gently sloping lacustrine	Exposed lake flats of extremely calcareous, loamy, very stony till	Poor to very poor	Odd salt tolerant plants
	Sagemace Series, (clay)	Rego Humic Gleysol, peaty phase	HBt1 3.1-3.2 fe/b	Depressional to level, gently undulating moraine	15 to 40 cm of mesic peat overlying moderately to strongly calcareous, clayey, slightly stony till	Poor	Black spruce, willow, sedges & meadow grasses
Sox	Soul Lake Complex (sand and gravel)	Eluviated Eutric Brunisol* Orthic Gray Luvisol Orthic Eutric Brunisol	LB1 3.1-3.2 fe/b	Ridged lacustrine beach and outwash veneer overlying ridged moraine	25 to 100 cm of strongly calcareous, stratified, moderately stony, fragmental to sandy-skeletal deposits overlying extremely calcareous, loamy till	Well	Jack pine, aspen and black spruce
Srx	Sand River Complex (fibric peat)	Terric Mesic Fibrisol* Terric Fibric Mesisol Terric Fibrisol	LB1-HBt1 3.1-3.2 fe/b	Level to depressional blanket bog	Shallow (40-160 cm) organic soils with a thin to very thick (65-160 cm) continuous fibric Sphagnum peat layer overlying subdominant mesic forest and/or fen peat. Underlain by strongly calcareous, sandy sediments.	Poor to very poor	Black spruce, Sphagnum and ericaceous shrubs
Tux	Tremauden Complex (sand and gravel)	Gleyed Eluviated Eutric Brunisol* Gleyed Gray Luvisol	LB1-HBt1 3.1-3.2 fe/b	Ridged lacustrine beaches and outwash	Stratified, calcareous, moderately stony, fragmental to sandy-skeletal deposits	Imperfect	Black spruce, jack pine and aspen
	Whithorn Complex (fibric peat)	Mesic Fibrisol* Typic Fibrisol Fibric Mesisol	LB1-HBt1 3.1-3.2 fe/b	Level to gently sloping domed bog	Deep (>160 cm) organic soils composed of fibric Sphagnum peat greater than 65 cm thick, overlying mesic forest or fen peat. Underlain by undifferentiated materials	Poor to very poor	Stunted black spruce with an understory of dominantly Sphagnum moss and ericaceous shrubs
	Warpath Series (clay)	Gleyed Gray Luvisol	LB1 3.1-3.2 fe/b	Level to gently undulating moraine	Moderately to strongly calcareous, clayey, slightly stony till	Imperfect	Black spruce aspen and balsam poplar
	Waskwei Complex (mesic peat)	Typic Mesisol, sphagnic phase* Typic Mesisol	LB1-HBt1 3.1-3.2 fe/b	Depressional to level flat and blanket bog	Deep (>160 cm) mesic forest peat with a very thin (< 65 cm) surface layer of fibric Sphagnum peat overlying mesic forest peat. Underlain by undifferentiated materials.	Poor to very poor	Black spruce with an understory of Sphagnum moss & ericaceous shrubs
Wy	Westray Series (loam)	Orthic Gray Luvisol	LB1 3.1-3.2 fe/b	Level, undulating & ridged moraine	Extremely calcareous, loamy, very stony till	Well	Aspen, white spruce and some pine and balsam poplar

*Dominant soil series

1 Mills, G.F., et al. 1978. Soil Climatic Regions in Manitoba. Canada-Manitoba Soil Survey, unpublished data

2 Clayton, J.S., et al. 1977. Soils of Canada

NOTE: Mapping units with blank colour boxes appear only as the secondary member of a complex soil unit.

SOIL PHASES

(d) Soils having improved drainage

(P) Mineral soils having an organic surface layer of up to 40 cm mesic peat or up to 60 cm of fibric moss peat

(s) Shallow mineral soils composed of 10-20 cm of mineral soil overlying bedrock

—•——•——•— small beaches (too small to draw line around)

- • —— • —— • — buried small beaches (too small to draw line around)

SOIL COMPLEXES

The individual soil series within each complex are listed in order of probable dominance. The dominant series is listed first, and is also indicated by an asterisk (*). This series gives the name to the complex.

SOIL MAP UNITS

Soil map units are named according to the soil complexes, series, and phases they contain. Arabic numerals placed after each soil symbol indicate the approximate proportion of each soil type within the map unit.

Example $B(P)^5 - B^3 - Mh^2$

TOPOGRAPHIC CLASSES

Single Slopes (regular surface)	Multiple Slopes (irregular surface)	Slope %	Approximat Degrees
depressional to level	depressional to nearly level	0 to 0.5	0
very gently sloping	gently undulating	0.5 to 2.5	0.3 - 1.5
gently sloping	undulating	2 to 5	1 - 3
moderately sloping	gently rolling	6 to 9	3.5 - 5
strongly sloping	moderately rolling	10 to 15	6 - 8.5
steeply sloping	strongly rolling	16 to 30	9 - 17

Cartography by the Land Resource Research Institute, Research Branch, Agriculture Canada, 1981.
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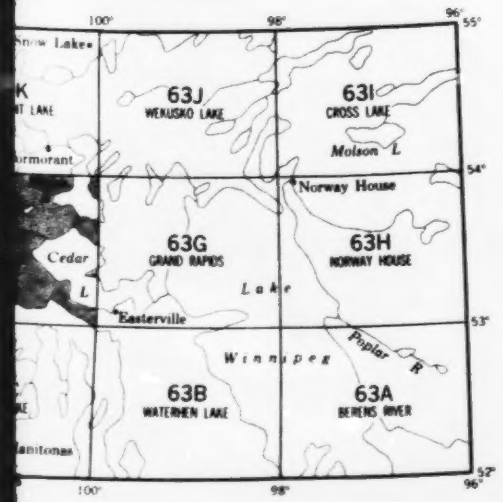
KEY MAP



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THE PAS AREA